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3, Amersham Road, HIGH WYCOMBE, Bucks.
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The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

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W. B. Lake, J.P., Lake & Elliot, Limited, Braintree, Essex.

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The Registered Office and Laboratories of the B.C.I.R.A. are :—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone : Colmore 4274-4275 Telegrams : CIRA

The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone : 332

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Wartime Developments

The war has now been sufficiently long in progress for its reaction on the foundry industries to be estimated. The immediate effect was increased activity amongst those catering for the various branches of the armed forces whilst a decline was registered in the section manufacturing castings for the building trades. During the last week or two there has been a distinct pick-up in the amount of work passing through the shops of the light castings foundries, although there is still a reserve capacity waiting to be filled. The steel foundries, including the new ones, are working at full pressure, and much the same conditions apply to the non-ferrous shops. Generally speaking, the control so far as iron and steel foundries are concerned is being very intelligently applied, though the merchants are by no means satisfied with the reactions on their business activities.

As announced elsewhere in this issue, the iron-foundry industry has established a liaison committee for co-operating with the Government and for seeing that the industry's resources are fully recognised, and utilised. This is a wise move, and is the consummation of a policy long advocated in these columns. The executive committee is a particularly strong one, but unquestionably its basis needs broadening to make it more representative of the industry. The textile-engineering and the agricultural foundries, to cite but two very important sections, are not represented. Cognisance should be taken either of the manufacturing sections or of geography.

The light alloy foundries have obviously been working at the highest pressure, and in order that the allocation and distribution of orders shall be properly undertaken, a voluntary scheme has been instituted. The machinery of control is to operate under the general direction of a management committee. The chairman of the committee is the Director of Materials Production, Air Ministry, and Mr. A. J. G. Smout is deputy chairman. The controllers include Mr. Percy Pritchard, for castings; Mr. W. C. Devereux, for forgings and stampings; Mr. Horace Clark, for extrusions, wire and tubing; and Mr. F. S. Mitman, for sheet and strip.

No doubt many foundry concerns, when they receive a letter from the Iron and Steel Control asking them to indicate whether they have any iron and steel scrap for disposal, will initially regard it as still another example of inefficient red tape-ism. Second thoughts will possibly reveal that their premises are the repository of scrap quite unutilisable in their own foundries. Typical of these are accumulations of sheet scrap, heavy pieces of steel, obsolete machinery requiring breaking-up plant beyond the capacity of the foundry, and scrap of a size and composition not normally or likely to be remelted. Moreover, if it causes a survey to be made of scrap not figuring in the stock book as such, the effort of the Control will not be in vain. In most works, there are mysterious pieces of piping, shafts, pulleys and the like rusting away against the walls of the shops. If the foundry manager does purloin a modicum of these, he will, nine times out of ten, be doing to-day's good deed. Such scrap is only kept by the maintenance department because "it might come in handy." When the appeal of a year or so ago was made for scrap, we strongly hinted that it was premature and that later the necessity would become more urgent. The time has certainly now arrived.

The research activities of the industry are being prosecuted at a reduced *tempo*, owing to the transfer of the staff to work of pressing importance. The British Cast Iron Research Association, for instance, is devoting much of its energy towards solving individual problems arising out of the screening of glare from furnaces. This work has shown the problem to be one requiring individual rather than general solution, because, connected with it, is the question of casting up moulds in daylight or in a well blacked-out shop.

The Institute of British Foundrymen held a Council meeting last Saturday in Birmingham, the attendance at which was well up to the average. The reports from the Branches showed that there is every prospect of a reasonably heavy programme being carried through. Quite a number of Branch Council meetings have been held, and to the surprise of everybody there have been larger attendances than normal. It is obvious that there is a strong desire to maintain the contacts which technical meetings afford, and to get advice on the new problems which the present transitional conditions have produced. The general dearth of social functions, too, is an incentive for people to foregather when reasonable opportunities present themselves.

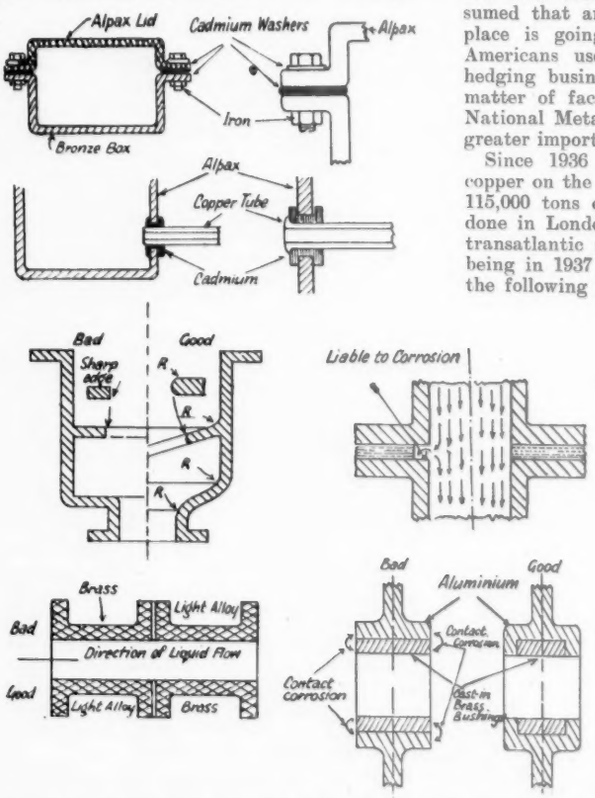
Non-Metallic Core Plates

Most of the large repetition foundries have in recent times been experimenting with core plates made from a "compound" of asbestos and cement. One make, the "Transite," handled in this country by J. W. Jackman & Company, Limited, of Vulcan Works, Blackfriars Road, Manchester, 3, has been the subject of conversations between a number of foundry managers and the writer. Generally speaking, the points which have been appreciated are lightness, strength, absence of corrosion, and low warpage. Even in the most efficient of mechanised foundries, core plates have to be handled in each cycle about six times, often by girl labour; thus a reduction of weight to one-quarter of that of cast iron is an important matter.

The strength of the plates has been favourably commented upon, and experience so far has shown that they suffer less than cast iron. The corrosion-resistance of the plates, since they are non-metallic, is of a high order, and certainly superior to some metallic substitutes for cast iron. Warpage is distinctly low and compares very favourably with that of cast iron. It is stated to be of the order of $\frac{1}{64}$ in. in 24 ins. of length. These plates are of Canadian origin, but happily a large stock of a wide range of sizes is held in Manchester.

Corrosion Avoidance in Cast Aluminium

Last week on page 264 we published a short article on this subject, and indicated that we would illustrate some of the hints referred to. The accompanying diagrams are self-explanatory. It should be remembered, however, that the designer has had as his object the elimination or reduction of corrosion hazards, and not merely the overcoming of foundry difficulties, though in quite a number of cases both ends are simultaneously attained.



The American Copper Market

By "Onlooker."

Necessity knows no law and apparently the authorities applied this dictum to the London Metal Exchange when they decided on the outbreak of war to suspend trading in metal futures with the exception of tin. This decision has come in for a good deal of adverse criticism but, in spite of reports to the contrary, trading in copper, lead and spelter has not yet been resumed.

For many years London has been the acknowledged head of those centres which specialise in trading in metals, and it is a grave misfortune that the exigencies of the present situation have made it necessary to suspend trading. As perhaps the only really "free" market for dealing in metal futures, Whittington Avenue has attracted business from all over the world and it is greatly to be hoped that the authorities will arrange for a reopening, if only with trading on a modified scale, as soon as possible. In the meanwhile what has happened to the business which formerly passed through London?

It is probable that some of it has been suspended, for consumers in this country for example who were in the habit of hedging their purchases in pre-war days when prices fluctuated, often wildly, no longer have this anxiety to contend with, because quotations are kept in a state of stability through the action taken by the Ministry of Supply. This is all very well for the British user, who incidentally is getting his metals at well below the values ruling in America and on the Continent, but people abroad are not so fortunately placed, and it must be presumed that any hedging business they have to place is going to New York. Moreover, the Americans used to send quite a lot of their hedging business to London, but this has as a matter of fact declined of late years since the National Metal Exchange in New York assumed greater importance.

Since 1936 when the turnover in standard copper on the New York exchange totalled about 115,000 tons or about one-quarter of what was done in London, the relative importance of this transatlantic market has grown, the proportion being in 1937 rather more than one-half and in the following year even more than that. It has been said that the American standard market is narrow and that it is impossible to buy or sell any quantity of copper without swinging the price one way or the other, but if this has been a trouble in the past, conditions are probably better to-day.

While the New York standard contract has taken London as a pattern, conditions of trading on the two markets naturally vary somewhat. For example, while in London trading is normally for cash and three months ahead, American practice permits of dealing for six or even eight months ahead, discounts or premiums—usually the latter—being deducted or added in line with the length of the "look forward." Another point is that settlements are made daily so that differences are received or paid from day to day instead of on the "prompt" date as in London. It does look now as if New York has a chance to consolidate its position as a centre for trading in metal futures, and the longer the London market remains closed the more difficult it will be to regain the former position.

Random Shots

It seems as if Saturday afternoons are going to be much in demand this winter. The return of league football (beginning last Saturday with goals at a shilling a dozen) will undoubtedly have its former popular appeal, for somehow, without its accompaniment of league tables to pore over afterwards, football seems to lose half its piquancy. It is like lamb served without mint sauce.

* * *

Many of the technical societies, including the Institute of British Foundrymen, are holding their winter meetings on Saturday afternoons, too, and it is quite certain that members will wish to make good attendance this year, football or no football. It was A. P. Herbert who once referred to the pleasure to be derived from "a conversation consisting entirely of technical terms." Practical foundrymen will appreciate the opportunities thus provided after weeks of enforced week-ends at home holding wool whilst the missus winds it into neat balls. Even at the week-ends, too, one has had to grow accustomed to staying at home, shelling peas instead of shelling the car. Yes, technical meetings have their points, after all, even when held on Saturday afternoons.

* * *

Generally speaking, with the help of many dictionaries and pints of beer, "Marksman" can translate quite a lot of languages, but confesses to be beaten by the reference in a New York contemporary to the "brain trust." It reads thus: "Goodbye Corcoran and Cohen and the rest of the 'hotdog' boys who have been allowed to play bingo with American futures. When the pinch comes and America feels the need of strengthening its team for the world series, out of the window go the sandlot boys and in come the professionals." It is undoubtedly a phrase-book rather than a dictionary that is required to understand American, especially when "hot."

* * *

Everyone has, at some time or other, been nonplussed by a searching and direct question from a child. The poser recently put by an inquiring youngster was, "How did Adam and Eve know how to talk to one another?" The suddenness of the idea was distinctly disturbing, but to have answered in the manner of the best politicians and lecturers that "I require notice of that question" would have been too great a confession of weakness. However, by the time the theory of evolution had been thoroughly expounded, the original question was entirely forgotten, which was very fortunate.

* * *

"Fault finders required for large radio firm. Good salary," reads a "small ad." in a daily newspaper. And to think people have been doing this for years for nothing!

* * *

"Sorry, I can't eat this stuff," said a small evacuee when his hostess served him with some shepherd's pie. "My mummy doesn't believe in secondhand cooking."

* * *

Conversation Piece.

1st little girl: "I'm going to marry a doctor when I grow up; then I shan't have any doctor's bills to pay."

2nd little girl: "Well, I'm going to marry a dentist; then I shan't have any dentist's bills to pay."

3rd little girl: "And I shall do better than both of you, because I shall marry a taximan, so I shan't have any taxes to pay."

"Marksman."

Cupola Melting Practice

A USEFUL LANCASHIRE DISCUSSION

At the first meeting of the Winter Session of the Lancashire Branch of the Institute of British Foundrymen, held on October 7, a Paper entitled "Melting Practice" was presented by Mr. S. E. Dawson, F.I.C., of the Stanton Iron Works Company. This Paper has previously been printed in our columns.

Mr. A. L. Key, President of the Branch, occupied the chair, and there was a large attendance of members, well up to pre-war normal standard, there being over 100 present.

In opening the proceedings the BRANCH PRESIDENT expressed the great gratification he felt in being able to welcome such a large gathering. The Council had decided that the business of the Branch, and the holding of meetings, should be carried on in the usual way even under the present somewhat trying conditions. Of course, no one could foretell precisely what might happen in the future, but there was one point upon which the Branch Council and the Institute were entirely agreed, and that was that the business of the Institute should proceed normally as far as possible. Doubtless a little extra effort would be required to make a success of the meetings, but he was confident that none of the members would hesitate to put himself to a little further trouble in order that they might continue their happy and most useful association one with another.

Whilst there had not been a meeting, in the customary course of events, since the previous April, it was most important that the personal touch should be maintained, in order that either by means of discussions following lectures, or by general conversation, foundry problems might be elucidated.

Unfortunately, Mr. J. Cameron, junr., who was to read a Paper entitled "Moulding Castings in Green Sand from Shell Patterns," would be unable to be present, being now engaged upon military service. Therefore it had been suggested and adopted by the Council that as a substitute the next meeting of the Branch should be devoted to the discussion of foundry problems generally. A "problem" always evoked discussion, and if any member brought any point forward for consideration, he could remain anonymous if he so desired.

The discussion in regard to problems could also be followed by a general consideration of the position of the foundry industry under present conditions, as it affected the members of the Branch in their own sphere of work. It was not intended to survey the national or the international situation, but merely to consider their own jobs in their own works, and to place matters upon the most practical basis possible.

The BRANCH PRESIDENT then drew attention to the fact that Mr. A. Boyes was now acting as the hon. secretary, *pro tem.*, of the Branch until the next general meeting, when his appointment would be confirmed. Having regard to the experience they had had already of Mr. Boyes' services, the Branch Council were fully satisfied that that gentleman would be a worthy successor to their ex-secretary, Mr. E. Cooke.

He then extended a very hearty welcome to the lecturer, who, he said, was well known to the members by name if not in person. They all realised that Mr. Dawson would impart information to them which it was well worth their while making an effort to come along and receive.

Vote of Thanks

MR. E. LONGDEN (Manchester), in proposing a vote of thanks to Mr. Dawson for his highly instructive and interesting Paper, said that sufficient material had been packed into about an hour's time to afford a basis for a score of lectures. There had been so much information imparted that one hesitated to commence to discuss it. With respect to the treatment by titanium, one had to assume the presence of titanium in pig-iron, although not all pig-irons contained it in sufficient quantity.

It was not a general question as to the quality of irons in general, but rather of a specialised type of them. He had had the opportunity of examining some of the photomicrographs of treated iron as shown by the B.C.I.R.A. Could Mr. Dawson deal with the total carbon content before and after treatment, because apparently there must be a reduction in the carbon content owing to the introduction of CO_2 gas. By using hydrogen gas there was a reversion to the large graphite flake. Was this similar in size prior to treatment with the CO_2 gas?

Mr. Longden, having ascertained that this was so, remarked that in that case there would not be a serious reduction of carbon by the first treatment.

He was particularly interested in furnace design, and in this regard he had in mind a cupola which was heated externally and there was a delivery of the hot gas to the cupola itself. He hoped to be able to address the members of the Institute on the matter at some future time.

Melting Costs

MR. FRANK ANDREWS (Hollinwood) seconded the vote of thanks. He referred to the melting cost in the cupola, which was stated to be 10s. to 15s. per ton. What was included in that melting cost? Was it all the coke, or all the firing material, all the labour, and all the overheads, etc.?

Another point which had been mentioned was the difference between the beginning of a cast in the blast furnace and at the end. This appeared to be another argument in favour of machine-cast pig-iron. They would all like to buy pig-irons instead of buying sand, because they did not soil the floor.

Cupola Patching Practice

Reference had been made in the lecture to the amount of ganister used per ton, and he understood that figures of 15 lbs. to 60 lbs. per ton were mentioned. His view was that quite a quantity of excessive use of ganister and refractory material generally was brought about by bad repairing. By this he meant that if a furnace burnt back, some furnacemen would bring it up level right away. He would like to know whether Mr. Dawson thought that was the correct procedure.

Mr. Andrews then illustrated his point by means of a diagrammatic sketch on a blackboard. It showed a concave erosion at the tuyere area.

Mr. Andrews stated that, assuming a 24 in. cupola, it was to be anticipated that there would be some "belly" in it, with a given blast pressure. If the blast pressure was increased, a further recession might be expected, depending upon the length of blow. In the case of a larger cupola, say 36 in., with a similar blast pressure, theoretically there would not be very much burning back. Probably, the blast pressure would not be sufficiently powerful, and would not reach across the cupola. He had found a tendency on the part of cupolamen to fill up the bellied-out gap. His own practice, with a 3 ft. cupola, was to insist on the furnacemen not making it up. A couple of sticks were supplied in order to make the necessary measurements day by day. The first day the furnaceman said there was going to be a burning back to shell, so he was told to try it for another day, when the report was that the effect continued to be similar. The idea was that in a 3 ft. cupola there should be about 1 in. of repair material, apart from large holes in the lining which should be made up with brick or ganister. He would like to learn whether it was the correct procedure to make up straight or to leave the cupola with a belly.

Hot-Blast Practice

Concerning hot blast, there was a book published 30 or 40 years ago, entitled "Sharp's Modern Foundry Practice," in which the statement was made that one could not get more out of 1 lb. of coke than there was in it. No extra heat, for instance, could be obtained. Personally, he was of the opinion that there was a great advantage in using hot blast. Apart from speeding up the process, he pointed out that, by means of hot blast, a higher temperature of combustion was obtained. There would be either hotter metal for the same consumption of coke, or less coke would be used to reach a normal temperature.

The vote of thanks was carried by acclamation.

Author's Reply

MR. DAWSON, in responding to the vote of thanks, said it was a great pleasure for him to revisit the Lancashire Branch, from which he made his first start as an Institute member.

In reply to Mr. Longden, the lecturer stated that in the titanium-CO_2 process the carbon was constant, and, of course, titanium was not present in all irons. It was usually present, in this country, in high-phosphorus irons, but where it was not present it could be added. It was a curious fact that if an attempt was made to add titanium to iron, in an increasing proportion, there was very often a reverse effect. An iron would merely take up a certain amount of titanium, and beyond that figure it would go into the slag, and if large amounts were added some of the original titanium would be taken into the slag. The carbon was not interfered with in quantity but only in size, and in the reversed process with hydrogen, the original graphite size was obtained, or even exceeded, depending on the duration of the treatment.

Cost of Melting

In reply to Mr. Andrews, the lecturer stated that the cupola melting costs given of 10s. to 15s. per ton of iron melted depended on the length of blow and various local conditions, and included the following items as an example:—

	s.	d.
Coke at 10:1 ratio	5	0
Labour	1	10
Lining repairs	1	5
Power—fan and hoist, etc. ...	0	3
Limestone, tools, etc.	0	4
Depreciation (10 per cent.) and interest (3 per cent.)	0	3
Metal melting loss (5 per cent.)	5	10
	14	11

Where very long blows were in operation, and consequently large tonnages were melted, the cost was very considerably reduced, but taking the more usual blowing times of 4 to 8 hrs., it was hardly to be expected that the price would be much below 10s. per ton. He added that these figures related to the metal as charged, and not to the weight of castings produced.

In connection with the variability of fracture and silicon in iron from the blast furnace, which necessitated selection after casting in most cases, Mr. Dawson agreed with Mr. Andrews that one of the principal advantages of machine-cast pig was the greater uniformity, since the metal was first tapped into a large ladle, which acted as a mixer to give a large quantity of metal well represented by a single analysis.

The absence of sand on the pig referred to by Mr. Andrews was also of great importance and value, and avoided much controversy between purchaser and supplier.

Patching Methods

Mr. Dawson agreed that in many cases it was not necessary to fettle a cupola back to the straight line, and under such circumstances a certain amount of ganister would be saved.

If too high a blast pressure were used, however, then continuous burning back would result, no matter what line the fettling had been brought to.

The blast pressure should be such as to reach to approximately the centre of the cupola burden, in order to give equal distribution of air across the charge. Excessive blast caused heat losses to occur up the walls of the cupola, where the charge was usually more open.

A hot blast applied to the cupola would give a greater concentration of heat in a narrower combustion zone.

Whilst it was true that one could not get more heat out of coke than there was in it, it should be remembered that the heat value in coke was sufficient to melt 40 times its weight of iron, though due to conduction into the cupola brickwork, etc., and radiation losses, only about one-quarter of this was transmitted into the metal.

Mr. A. Sutcliffe (Bolton) said that a balanced-blast type of cupola was being used in Manchester some 45 years ago, not many hundred yards away from where the Branch was holding its meeting. He mentioned also a number of general foundry difficulties which Mr. Harold Haynes (Liverpool) suggested should be passed on for consideration at the next meeting of the Branch. This course was unanimously adopted.

Bed Charges

Mr. A. Hopwood (Liverpool) remarked that the presence of coke in the bed was intended solely to hold up the burden of the charge. Had anyone present any information of other means as to holding up charges in the furnace?

Mr. Dawson replied that different methods had been tried, with a certain measure of success, for holding up a charge without the use of coke. One method adopted was to use refractory bricks built in chequer work. This method worked reasonably well. A cupola was placed on the market many years ago which had a central stage inside it. This did away with the use of the coke bed, and it proved to be quite an efficient melting unit.

Coke provided an easy method of maintaining the charge in its correct position. At the same time it gave off heat at the spot in the cupola where it was most required, since a certain amount of super-heating was given to the metal by its passage through the coke bed, which was raised to incandescence by the blast.

In his opinion the more the metal was superheated the better would be the quality of the metal produced.

Oxidation Zone

Mr. A. Phillips (Manchester) said that the statement had been made that oxidation by air in a well-packed cupola was not detrimental to the metal.

In reference to one of the slides, the lecturer had stated there was 46 per cent. of wasters with 260 cub. ft. of air in volume. Further on in the slide there was shown 3 per cent. of scrap and 165 cub. ft. of air per min. He would like to know what was the type of scrap in the castings, and how it was associated with excess air.

Dealing with slag inclusions and titanium, Mr. Boyles, of U.S.A., had published a considerable amount of literature concerning them; but he, the speaker, had not seen any slides of his work yet.

Mr. Dawson had shown, by means of a slide, the effect of the reduction in the size of graphite flakes by bubbling CO_2 through; but he, the speaker, had not seen any slides of a metal so treated and not containing titanium.

Mr. Dawson said that it was possible to have increased air supplied to the cupola without producing oxidation, because increased air in the blast gave increased melting rate. Therefore, the ratio between air and coke went up very slowly, and there was not necessarily oxidation of the iron. When a certain figure was exceeded, however, he had tried to indicate, by means of a slide, that oxidation then took place, as it did also in an open-spaced charge.

Under such conditions as the latter the iron readily absorbed any excess oxygen which was present, thus bringing about oxidation of such elements as silicon, manganese, and carbon.

It was necessary to distinguish between good cupola practice with increased air volume and melting rate, and bad cupola charging, for example, by the use of large, hollow scrap.

Proper packing or proper laying of the charge in the cupola was necessary, and the scrap or some of the pig-iron must be placed on the outside, in order to reduce to a minimum excessive spaces which would occur between the outside of the charge and the wall.

Regarding the treatment of iron without titanium, the lecturer regretted that he did not bring slides with him showing the effect of CO_2, but he could assure them that the effect was negative.

The Future of the Institute

Mr. T. Makemson (secretary of the Institute) then addressed the members of the Branch. He was aware, he said, that the members of the Institute were expecting to receive some sort of guidance with regard to the policy to be pursued for the duration of the war. A few days before war was declared the question was discussed by the President and the members of the Executive Council. Those gentlemen decided very wisely, in his opinion, if he might be permitted to say so, that they would not make any difference in policy for at any rate some weeks to come. They realised, as many other people were now beginning to understand, that things which were done in a hurry in the first few days of the crisis would very likely have to be amended. Therefore, the President and the Executive Council had decided not to make any drastic changes in policy for the present. They wrote to all the Branch-Presidents and asked them to continue as far as possible with their existing arrangements.

Several of the Branches were doing so, and the Lancashire Branch was endeavouring to carry out its programme for the session on lines laid down earlier in the year. Judging by the attendance of members that afternoon, it was obvious that the President and the Executive Council could take it that their decision had met with considerable approval and encouragement. Such a magnificent attendance of members was certainly an indication that the policy adopted was regarded as being one of wisdom.

Other Branches were endeavouring to follow the same course. The Scottish Branch had roundly declared that they could not see why the war should interfere with their affairs. Other Branches which had to contend with special local conditions were not quite so sure how they would be able to carry on. Some of them had suspended their meetings for the time being, but they would reconsider their position probably in a month or two, according to the light which future events might cast upon the general situation.

The main thing was that it was necessary to keep the Institute going throughout the whole of the war period. It would be more useful to its members during such a time of stress than it would be even in normal times, because they could all get together and exchange ideas with a view to rendering one another assistance in dealing with unusual problems.

During 1914-18 the Institute made remarkable progress. Its Branches held all their meetings, and the Institute finished at the end of the war period with a considerably increased membership.

Admittedly conditions might not be similar during the present war, but they must all try to keep together and carry on the business of the Institute as efficiently as possible.

There might be occasional cancellations of lectures—there was one for November in the case of the Lancashire Branch—but adequate means would be adopted in all cases to fill the gaps created. The Institute could keep going, but they desired support from all the members.

Mr. Makemson again thanked the members of the Lancashire Branch for their attendance, and expressed the hope that at the conclusion of the war period the Institute would be found to be in an even stronger position than it was at the commencement of the crisis.

Hardness Numbers

B.S.I. APPROXIMATE COMPARISONS

The British Standards Institution has just issued a table of approximate comparisons of hardness numbers, B.S. No. 860. With the increasing adoption of hardness testing, there has arisen a need for a means of comparing the units of hardness of one system with those of another.

At present the most widely employed methods of measuring hardness are the "Brinell," "Diamond Pyramid," and "Rockwell" tests. There are individual preferences for using these, but cases are increasing where the same material is tested in different works or laboratories by these three different methods. There has, in consequence, been a general demand for some means of correlating the most used A, B and S scales of the Rockwell test with those of the Brinell and diamond pyramid tests.

Investigations show that there can be no general theoretical relationships between these scales and empirical formulæ devised from experiments only hold closely for materials of approximately similar composition and in a given condition. "Variations" in the empirical relationships result if the conditions as regards composition, heat-treatment and cold work differ appreciably, and also if different loading ratios are selected in the Brinell test. On the other hand, groups of materials which are similar as regards composition, cold work, etc., may give fairly close comparisons. It has accordingly been emphasised that the table is at the best a general approximation. It is issued merely to give an indication of the order of the relationship between the three systems of hardness readings, and must not be used as a standard for the conversion of hardness values given on one scale in any B.S. Specification to those of another scale. The diamond pyramid scale has been taken as the basis of reference, and the most probable comparative values adopted from published experimental results.

Copies of this British Standard can be obtained from the British Standards Institution, 28, Victoria Street, Westminster, London, S.W.1. (price 2s. 2d. post free).

Birmingham Metal Business Purchased

The business of Burt Bros., Limited, Crescent Copper Works, Edward Street, Birmingham, has been bought by Sheffield Steel Products, Limited. Mr. Thomas Nightingale, a director of Sheffield Steel Products, has been appointed chairman. Burt Bros., established before 1780, are coppersmiths, metal spinners, brassfounders, stampers and piercers.

Phosphor-Bronze Castings of Heavy Sections*

By A. HOPWOOD

The object of this Paper is to describe the successful production of some bronze castings which are not difficult to mould, but which require special production methods to obtain correct structure and soundness. This is especially true where castings have heavy machinings and sections thicker than normal. It is also proposed to stress the importance of correctly-rammed moulds, using permeable sands, to resist the hydrostatic pressures, particularly when making full use of high heads for this purpose. Obviously, many variables can influence the creation of a casting. Many castings which are not up to standard in respect to Brinell hardness and density are ascribed to inadequate casting temperature and furnace practice, whereas the mould condition and material, coupled with the slow cooling consequent upon mass, can be responsible, and very often are, when using sand moulds. A few years ago castings made in relatively short freezing-range alloys and cast in green sand moulds were suitable for the engineer. Castings made in phosphor bronze of specified Brinell test on sliding and bearing

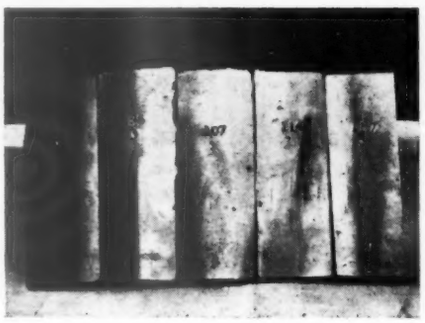


Fig. 1.—Chill-Cast Bars after ⅛ in. Machining.

faces and required to show no porosity on inspection, even after heavy machinings, call for more careful treatment. The cost of moulding methods has to be considered in the light of the best possible casting that can be produced, depending upon its requirements in service.

One of the most important problems of modern machine-tool production is the bearing and sliding surfaces. Additionally there is the tendency to increase speeds and loads on the smallest possible size of bearing faces, because an increase in the size of the faces involves more horse-power to overcome frictional resistance. This requires more attention to be paid both to materials and methods of lubrication. The production of alloys tested and proved in the laboratory is by no means sufficient; the results must be reproduced in the castings. When the design and material have been proved to be correct, there are many factors which affect the life of bearing faces, not all of which are foundry influences, although this department has to be responsible for the raw material and the initial "as-cast" structure. A hot bearing is usually the first indication that all is not well, the oil breaking down under the retention and amount of heat generated.

Causes of Hot Bearings

Some of the main factors affecting these conditions are:—(1) Faulty machining where the final surface has been plucked and disturbed, leaving the delta phosphide eutectic loose and liable to come adrift early on in the running period; (2) insufficient clearances allowed and wrongly disposed oil grooves, bad fitting, bedding and scraping; (3) sand left in the main casting which may foul the oil supply and choke the filters; and (4) one which is always open to the first investigation—the incorrect structure of the bearing materials.

It is therefore obvious that the foundry, to fulfil its obligations, must produce a casting not only true to size and shape, but also internally sound and true to structure irrespective of design or planned machining methods.

The manufacture of castings in standardised alloys involves in many cases specialised production. The slow cooling and mass-effect in heavy

Fig. 2.—Fractures of the Chill-Cast Bars.

castings and the quick cooling in lighter ones indicate that ordinary sand methods are not always sufficient to produce the structure required, and more care and expense are demanded to produce the successful casting. The practice of altering the mixture to suit the type and section of the casting as practised in the ferrous foundries has much to be said for it, but is not permissible where the alloy is specified, as is usual in non-ferrous practice.

Experimental Details

Table I details a simple test carried out to ascertain the effect on the structures and chilled faces of deliberately overheating phosphor bronze and casting it into a series of chill and green sand moulds at definite temperatures. The density and two Brinell numbers, one after ⅛-in. machining and the other after ¼-in. machining, were taken. The bars were 6 in. long, 2 in. wide by 1¼ in. thick, there being five "green-sand" and five "chill-cast" bars available. The latter group was chilled on the faces equal to their section thickness (1¼ in.). No dressing was used in any of the moulds to avoid any conflicting elements, and no feeding was applied to any of the bars. The runners and gates were standardised at ¼ in. by ⅜ in. by 1 in. long; the down peg at ½ in. dia. associated with a head pressure of 4 in. The alloy was melted in a rapidly operated coke-fired pit furnace to just over 1,350 deg. C., and the metal was withdrawn and cast into the bars at temperatures detailed in Table I. No dressing was used on the chills, but precautions were taken to see that they were completely dry and cold when rammed up in sand. The outer appearance of the chill-cast bars was very interesting, for bars cast at 1,300 and 1,250 deg. C. showed deep-seated blowholes on all faces in contact with chills, the bar

Table I.—*Effect of Casting Temperature on Phosphor Bronze.*

Chill-cast.

Casting temp., deg. C.	1,300	1,250	1,150	1,100	1,000
Density	8·47	8·53	8·62	8·83	8·84
Brinell No.—					
After ⅛-in. machining	96	96	107	114	117
After ¼-in. machining	93	93	104	110	114

Green-sand cast.

Casting temp., deg. C.	1,300	1,250	1,150	1,100	1,000
Density	7·92	7·95	8·37	8·62	8·57
Brinell No.—					
After ⅛-in. machining	69	92	95	112	85
After ¼-in. machining	69	72	78	85	85

cast at the higher temperature being the worse as in this case the casting contained a wormhole defect.

This represents a trouble which can always be associated with over-heated chills during the casting period, and can arise from several faults, individual or collective. All the bars were true

Fig. 3.—Green Sand Bars Cast under the Same Conditions as the Chill-Cast Series.

to shape, except the one cast at 1,000 deg. C., which had a badly sunken top face, whilst one side had "pulled" a little. The chill-cast bar cast at 1,100 deg. C. had just a trace of sink showing.

Fig. 1 shows all the chill-cast bars after machining ⅛ in. of one face and Brinell testing. The worm holes on the bar cast at 1,300 deg. C. are visible on the one at the extreme left. Fig. 2 shows chill-cast bars after fracturing cold; worm holes are present in No. 1, whilst No. 5 shows a large hole with a porous discoloured area beneath it. This was cast at 1,000 deg. C.

The fractures were sound generally, there being no discoloration due to gas liberation or intercrystalline cavities; a gradual decrease in grain size from 1 to 5 was exhibited. The general colour of bars Nos. 1 to 3 was fawn with a greyish-blue area in the centre. This increases outwards as the casting temperature decreased, until at 1,100 deg. C. (No. 4 bar) it practically covered the whole of the fracture. The greyish-blue colour represents the normal segregation of the delta phosphide eutectic to the centre. No. 4 cooled too quickly to allow it to segregate. The condition of the No. 5 bar showing the large cavity with a porous area beneath is due to lack of time for the gases to escape and the metal feed properly. A riser or flow of metal through the mould would have given sufficient time for the gas to be driven out; the general structure, however, is perfectly sound and free from discoloration.

* Paper presented to the London Branch of the Institute of British Foundrymen, Mr. Barrington Hooper, C.B.E., presiding.

When tin bronzes are cooled quickly through the solidification range, the structure increasingly tends to be thrown out of equilibrium, involving an increase in the amount of delta constituent. This is inevitable where the use of quick cooling is resorted to, and can be an advantage or drawback, depending on its situation. Also, with an increase in the cooling rate, there is more latitude in casting temperature, but this latitude, if made use of in every case, would lead to defective work. For instance, where there is a chilled outside with a small diameter bore of 5 in. or less, then by making use of a higher casting temperature than is normally used on a similar all-sand mould, there would be ideal conditions for a porous bore due to the segregation of the last metal to solidify towards the hottest area. This would be the area around the core. The use of chills is to increase the rate of cooling and so obtain a smaller grain size, better distribution of delta phosphide and easier feeding. By increasing the casting temperature this is defeated; moreover, the higher the casting temperature the greater is the danger of blown castings due to overheated chills. The initial chill temperature is also of primary importance and, the lower it is, the more rapidly the liquid metal commences to solidify and build up on it. If this is not observed, trouble from overheated chills, particularly at parts where relatively hot metal is flowing (as from ingates), is likely to occur.

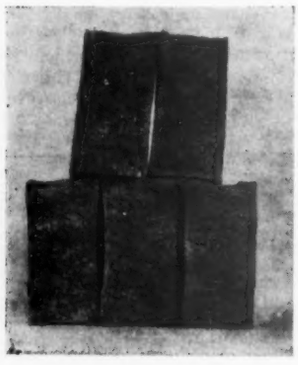


Fig. 4.—Fracture of Green Sand Test Bars.

Porosity cannot be readily overcome in massive castings by the intelligent control of casting temperature, although it has a profound influence on it; the solidification range for any particular alloy remains the same, but the rate of cooling can be accelerated by low casting temperatures and greater heat abstraction from the cooling metal as by the use of chills or some similar materials.

Green Sand Tests

Fig. 3 shows the green-sand bar series cast under exactly the same conditions as the chill-cast bars. There was a difficulty in getting a clear Brinell reading on No. 6 bar, due to the openness of the metal. The general appearance of the machined surfaces was very unsatisfactory, because of this pronounced porosity, the No. 9 bar cast at 1,100 deg. C. being the least contaminated.

The fracture of green-sand bars is shown in Fig. 4. The No. 6 bar, drawn at the runner gate, had gas holes showing after fettling. The fracture showed a "broken-up" appearance, with the well-known red patches covering the whole of the section. Bars Nos. 7 and 8 were similar, but not quite so bad. Bar No. 9 had no unsoundness showing at the runner gate after fettling, but the fracture did not show any red spots, although it had not a good appearance, generally looking "loose" in character. No. 10 bar was sunken badly on the top face and on one of the side faces. On removing the gate, it showed soundness, whilst the fracture displayed trapped gas-holes and a return of red spots, probably due to intercrystalline shrinkage caused by the extremely low casting temperature and insufficient time for feeding.

Fig. 5 shows the bars cast green with another $\frac{1}{8}$ in. machined off, making $\frac{1}{4}$ in. total. There has been a general lowering of the Brinell readings and an increase in the appearance of the porosity on the machined face. The extra machining on the chilled bars made nothing like the same decrease in the Brinell figures, nor did the appearance of the machined face present any trace of porosity. There is not the slightest doubt that the bars with metal cast at 1,100 deg. C. are the best of the two series, but the chill-cast bars where the metal has cooled most rapidly through the solidification range are the most satisfactory of the two sets.

Fig. 5.—Green Sand Bars after $\frac{1}{4}$ in. Machining.

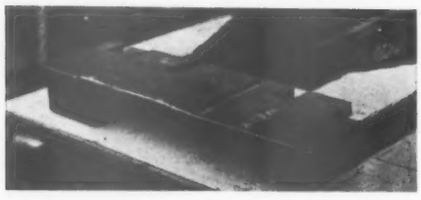


Fig. 6.—Density Test Casting.

Conclusions to be Drawn from Tests

The chill-cast bars prove that there is a greater latitude in casting temperature to ensure a serviceable casting having fine grain and sound, even structure throughout the mass, whilst giving good density and Brinell hardness for that particular alloy. The fallacy of utilising this advantage too much and casting on the high-temperature side is to induce a tendency of segregation of the delta phosphide to parts of the casting last to solidify and a danger of the burning-on of the chills or at least overheating them.

The loose open structure which is so prevalent in heavy-sectioned, sand-cast phosphor-bronze castings is particularly dangerous in heavily-loaded bearing surfaces, the delta phosphide eutectic showing in relatively large masses—often with small microscopic fissures leading off, giving looseness of the structure. Any alteration in normal running conditions, such as rise in temperature and final breaking down of the oil or stoppage of the oil supply for any reason, is ideal for this loose constituent to be plucked out and become an abrasive in action.

In normal-section castings, the practice of controlling the foundry technique such as running and gating, feeding, casting temperature, and melting generally overcomes this weakness, but in castings having abnormal general section, the above precautions are insufficient to overcome the annealing effect and the slow cooling through the solidification range; this yields low density and low Brinell readings. The use of very low casting temperatures is not a solution; they often lead to unsightly castings with trapped-gas holes on the top machined faces and, if the mould "eases" or "gives" a little, intercrystalline shrinkage cavities. The use of materials to form the mould which will conduct heat away much more rapidly than sand and so hasten the cooling through the critical range, coupled with the usual precautions, is essential if a casting sound in every respect be required. The build-up of the structure and the feeding generally must be much improved, even when the chilled area is not the major portion of the mould.

These tests which show that bars chill-cast or cast at a temperature usually associated with sand castings give better Brinell readings even after heavy machinings are amply borne out in practice. Soundness and a close structure—impossible by ordinary methods—are obtained.

Examples of Faults

Large castings thrown out of normal setting by machining more off one side and correspondingly less on the other will result in one face giving high and the other low Brinell readings. When using skeleton patterns or boards, there is a great temptation for moulders to work "safe," that is, under-size for the internal sizes and oversize for those outside, thus making for additional machining. Soft ramming, resulting in swollen castings, is generally regarded by the moulder as just a little more extra machining.

Fig. 7.—Microstructure of Section against the Chill.

Slow cooling, due to large amounts of metal passing over one section and thus causing hot spots, will give the same results as will hot moulds. Even with alloys which should normally and easily satisfy the test the above faults will give failures, proving that indiscriminate hardening of bronze alloys by extra additions of tin and phosphorus is only a part solution to meeting specifications.

It should be generally realised that these increases of hardening elements only make the possibility of low density greater in bulky castings, due to the increase in the amounts of last metal to solidify and a greater difficulty of feeding "sound" the whole of the casting. After all, if by quick cooling and a cheaper alloy one can get more consistent tests and better structure it should have some consideration if only for the advantage of much easier manipulations in the foundry.

Inverse Segregation

There is not the slightest doubt that segregation (normal or inverse) of the last metal to solidify is responsible for internal and general openness of the structure. It is not always shown by tin sweat appearing at the risers and runners in large castings and at low temperatures. It

is not difficult to visualise the method of crystallisation and build-up of the structure in large sections cast in sand. Due to the low conductivity of heat of the sand, the rate of cooling will be relatively slow after the first deposition of solid metal, even with very low casting temperature. The speed with which the dentrites build up into the interior of the metal thickness depends on the size of section. The slower the rate of cooling, the more will the dendrites spread into the section having still-liquid metal around them. Near the outer edge, diffusion takes place, leading to large dendritic growth and virtually isolated pools of still-liquid metal.

If gas be present in the alloy, it may be concentrating in the liquid metal until the temperature drop is sufficient for it to come out of solution. The amount of undercooling depends on the rate of temperature fall and agitation and this has some bearing on the incidence of pressure the gas can exert on the remaining liquid. Thus, quick cooling due to low casting temperature and cold mould conditions, aided by slow cooling due to mass, can lead to general porosity under the skin. The appearance of tin sweat depends on the casting temperature and general conditions.

R. Genders' work and conclusions on inverse segregation and porosity are borne out in practice, the gas theory being admitted to explain the internal pressure required to force the remaining liquid out of position. The main factors are the composition of the alloy; the rate of cooling; the pressure of dissolved gases, and the casting temperature. The rate of cooling is effected by the heat transfer from the mould materials.

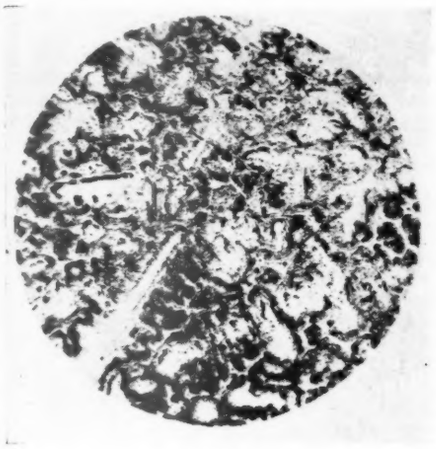


Fig. 8.—Microstructure of Section against Dry Sand.

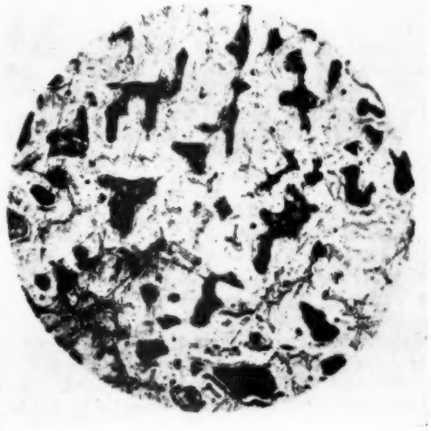


Fig. 9.—Microstructure of Section against Soft-Rammed Green Sand.

Experiments in Density

The second test for density is a most important one for those connected with castings production using sand moulds, particularly in the case of alloys having long solidification ranges. A mould 30 in. long by 9 in. wide by ¾ in. deep, provided with a longitudinal runner and six ingates of 1 by ¼ in., devoid of feeding arrangements, was made. The metal used was 11 per cent. tin, 0.15 per cent. phosphorus, the remainder being copper. It was cast at 1,100 deg. C. Six inches of the bottom of the mould were chilled, 6 in. were in dry sand, 12 in. in soft-rammed green sand, finally 6 in. of green sand normally rammed. Tests were made for density (see Table II) and microscopic examinations were carried out.

Fig. 6 shows a photograph of the casting, and indicates the position from which the test pieces were taken. The soft rammed section is 1 in. thick, the mould having "eased" about ¼ in.

Doubtlessly, high head-pressures produce sounder castings, mainly by driving the mould gases out into the atmosphere by the correct way. This involves the use of moulds sufficiently rigid to withstand the hydrostatic pressure from the time the mould commences to fill until the casting is completely solid. Phosphor bronze solidifies over a range of temperatures, depending on the composition, whilst the time is in relation to the thickness of section; as the section becomes greater so does the time lengthen, and any easing of the mould during this period is bound to upset the method of solidification.

Table II.—*Result of Density Tests.*

	Density.	Fracture.
Chilled	8·71	Close.
Dry sand	8·75	More open.
Soft green sand ..	8·13	Very open, showing red discoloured fracture.
Normal green sand	8·69	Similar to dry sand result.

Faults due to Mould Conditions

Attention was first given to this phenomenon by the dissimilarity between two castings made off the same pattern and cast out of the same pot of metal at the standard casting temperature whilst using the same method of running and gating. The one casting would have good density and adequate Brinell hardness, whilst the second would yield a casting low on test with a machined surface of dull appearance. On fracture such a casting would show the usual discoloration associated with improper casting temperature. As gas and segregation conditions in one of the castings were perfect, the defects could not be due to the previously mentioned faults, although anyone not knowing the circumstances could be forgiven for such an assumption. It could, of course, be due to only one cause, that is, the condition of the mould or mould material.

The first indication that the mould has "given" is an excessive sink in the riser, and on measuring the casting it may be locally oversize or in extreme cases completely oversize; thus excessive metal has to be machined off. As pointed out previously, this alone is detrimental to the appearance of the casting and to the Brinell test. The explanation is that, when a mould is just cast, the portion of the mould giving way requires more metal which is drawn from adjacent areas, and, lastly, from the risers supplying the section underneath it. If these conditions persist after the metal has commenced to solidify, the position is aggravated by the liquation of the still-liquid metal to the parts requiring it and a consequent starvation in other parts, thus giving rise to intercrystalline weakness and porosity.

In this test, an attempt has been made, with some measure of success, to create a condition similar to the above, showing the deleterious effect of weak moulds on the castings made in alloys having a long solidification range. The density tests are in agreement with what was expected, as were also the fractures. Figs. 7 to 9, showing the microstructures of the various sections, are remarkable for the differences in structure. It would appear that the metal had been melted and cast under different conditions. Many castings made defective by the mould and mould material are ascribed to bad melting and casting temperatures, particularly by those lacking personal contact with practical foundry conditions. Many castings are made in dry sand not because they cannot be made in green sand, but so that a strong mould is made having a good permeability, with a minimum gas effect on the alloys poured very near their solidification temperature.

(*To be continued.*)

Control of Machine Tools

The Minister of Supply has made the Control of Machine Tools (No. 1) Order, 1939, dated October 6.

The Order provides that every person engaged in the production, keeping, distribution, disposal, acquisition or use of machine tools situate in the United Kingdom shall comply with any directions or instructions issued or given by the Minister of Supply as to: (*a*) The descriptions and quantities or numbers of such machine tools which are or are not to be produced, kept, distributed, disposed of, acquired or used by that person; (*b*) the persons to and from whom and the prices at which any such machine tools are to be disposed of, or acquired; (*c*) the location of any premises intended to be used for or in connection with the production, keeping, distribution, disposal, acquisition or use of any such machine tools; (*d*) the purpose for which and the place at which and the manner in which any such machine tools are or are not to be produced, kept, distributed, disposed of, acquired or used; (*e*) the use of drawings, patents, designs and trade processes for or in connection with the production or use of any such machine tools; (*f*) sub-contracting any work to be done for or in connection with the production or use of any such machine tools; and (*g*) generally all matters affecting the production, keeping, distribution, disposal, acquisition or use of any such machine tools.

It is further provided that such books, accounts and records as the Minister may require shall be kept. The expression "machine tools" in the Order includes any mechanical contrivance for cutting, forming, abrading, polishing or otherwise working wood or metal; and any accessory, small tool or equipment therefor.

Patent Specifications Accepted

510,759. Soc. D'Electrochimie, D'Electrometallurgie et des Acieries Electriques D'Ugine, and Andrieux, J. L. Process for the manufacture of alloys of silicon.

510,778. Deutsche Eisenwerke Akt.-Ges. Method of manufacturing materials and work pieces of mineral wool and a hydraulic binding medium.

510,793. Siemens & Halske Akt.-Ges. Production of metallic coatings or layers by the vaporisation of alloys in a high vacuum.

510,822. Kohle- und Eisenforschung Ges. and Deutsche Rohrenwerke Akt.-Ges. Heat-treatment of steels that are heat-resistant.

510,845. Griffiths, S. H. Method of self-stripping an ingot from a mould.

510,871. Bolton, C. A. Manufacture of iron or steel articles having protective coatings.

510,963. Kellogg Company, M. W. Production of pipeless ingots.

511,041. Roberts, S. T., Taylor, F., and Palmer, E. C. Descaling of metal articles.

511,074. Harris & Sheldon, Limited, Sankey & Sons, Limited, J., and Butler, H. G. Metal pillars or stanchions for use in the construction of partitions for rooms and the like.

The Sandontap Moulding Process

Our representative recently had the opportunity of seeing a demonstration of this process at the Phoenix Iron Works of Messrs. Richards (Leicester), Limited. The essential characteristic of the system is that it provides a stream of highly-permeable sand which readily and quickly fills a moulding box with sand of a "rammed" hardness which can be varied at will by adjusting the pressure of the air used on the installation. The plant inspected consists of a sand container taking the form of a narrowish cylinder connected at its base with an inverted cone. This section of the apparatus is designated by the inventor, Mr. Victor Stobie, as a "generator." In the conical section of the machine there revolves an agitator working at a low speed. This is actuated through a reduction gearing operated by a 20-h.p. motor. This is stated to be too large but happened to be available on site and 15 h.p. would easily suffice. Air taken from the mains at 80 lbs. pressure is stepped down by a reducing valve to 50 lbs. for iron sands and still lower for steel sands, especially where these are made up with bentonite and the like. The mixture of sand and air is taken off by a 1½-in. pipe passing through the wall of the building. Externally it is carried by a flexible pipe looped over the carrier arm. This swinging arm is jointed mid-way along its length, the two joints running in ball bearings. The flexible pipe is connected to a metal tube attached vertically to the end of the arm. At the delivery end the pipe carries a 1-in. dia. threaded nozzle. The end of the nozzle is normally maintained about 3 ft. from the pattern. In order that deep boxes may be properly rammed, adjustable extension pipe pieces are screwed into the nozzle. Apparently there is no wear at all on the nozzle, for the threading after a month's wear was still quite untouched. On the pillar supporting the arm is a lever for starting and cutting off the supply of sand. This is to be replaced later by an electrically-operated cut-off.

Performance Details

Though the generator for this demonstration plant is only about 7-ft. high by 3-ft. dia., the measured rate of output of rammed sand is in excess of 5 tons per hr. If the stream of sand is uninterrupted the outflow of sand is 7 tons per hr. The air consumption is of the order of 160 to 200 cub. ft. at 50 lbs. pressure per ton. These figures together with the cost of running a 15-h.p. motor will enable our readers to calculate the cost of ramming a ton of sand under their own conditions of compressed-air production and electricity charges.

The stream of sand seems to throw out any large sized piece of rock or sand which has not been properly milled. The parting for two or more parted jobs is found to be best made by sprinkling bone dust on the surfaces and passing a trowel over it, as if the parts were just sprinkled with parting sand the on-coming stream of moulding sand would disperse it. Enhanced speed of motion of the delivery pipe over the moulding box increases the ramming density as smaller layers are superimposed on each other. The best moulding results are obtained with a little less moisture than is necessary for hand or machine moulding, but sand carrying 10 per cent. of moisture has been successfully rammed, whilst the sticky bentonite steel sands are stated to have brought about no difficulty. On one occasion the permeability of a close iron sand was shown to have increased from 28 to 42 during processing. The writer was informed, but did not actually witness the phenomenon, that the moulds when cast up show surface flames all over the upper surface.

Potentialities

The obvious immediate application of such a system is for the jobbing shop, organised either to carry a number of moulding stations to be piped up to the generator, perhaps incorporating portable pillars and arms, or the provision of means to bring a series of moulds beneath the moulding station. The mechanical filling of the generator is an essential, and certainly its positioning adjacent to a proper sand preparing plant is desirable. These conditions being granted the plant has every appearance of fitting into quantity-production continuous plants. Naturally there would have to be more than one generator, for whilst one was being emptied the second one would be filling. A third potentiality is for the ramming up of sizable cores, not suitable for the usual blowing systems.

Finally it is interesting to compare this equipment with a pneumatic moulding system of German origin shown at an exhibition in London some years ago. That machine never impressed the writer as being a technical success, as choking up of the pipes was experienced if the sand was sufficiently moist to mould.

The writer understands that the U.S. Steel Corporation are putting down an installation at their Chicago-Illinois Works. If any of our readers would specially wish to see a demonstration of this system during the next week or so, provisional arrangements can be made for this with the Sandontap Company of Dunston House, Harrogate.

Advantages

It is not intended to enumerate the specific advantages such as one would set out in publicity matter, but rather does it seem desirable to underline the quietness of the process and to stress the paucity of the parts requiring lubrication. The only portion where any wear has been found is in connection with the tips of the agitator blades, and here hard steel is to replace the mild variety now being used.

Privately-Owned Railway Wagons

The Minister of Transport has appointed a committee to advise him upon questions arising out of the requisition of privately-owned railway wagons.

The committee consists of representatives of the Ministry of Transport, the Mines Department, the Railway Executive Committee, the Association of Private Owners of Railway Rolling Stock, the Scottish Wagon Owners' Association, the Association of Wagon Repairing Companies, Hirers, Limited, the Railway Carriage & Wagon Builders' and Financiers' Parliamentary Association, and the Mining Association of Great Britain.

Ironfounders' National Committee

A letter has been addressed to ironfounding firms making all forms of cast and malleable cast iron, and irrespective of whether ironfounding forms the whole or only a part of their business, or whether they produce castings for resale or in the form of finished products.

The firms and bodies whose names are appended, representing an annual tonnage of 1,800,000, met at York on September 15, with a view to seeing if it were possible to form a wartime organisation which would enable the industry to speak with one voice, irrespective of any sectional interests, and also to be a channel through which the Iron and Steel Control could speak to the industry as a whole. It was pointed out that there are approximately 2,500 foundries and a variety of associations in the industry, and thus it was a practical impossibility for the Control to contact the industry, unless there was in existence a central body which could function regardless of any sectional interests.

It was agreed to constitute the Ironfounders' National Committee for this purpose. (It should be noted that the word "Committee" is employed to avoid the use of the word "Association.") The following resolutions were passed:—

(*a*) *Assistance to H.M. Government.*—The members present, representing the cast-iron industry of Great Britain, unanimously agreed, for the purpose of assisting H.M. Government to obtain its defence requirements, that they would pool their technical and manufacturing resources. The Ironfounders' National Committee had therefore been formed for this purpose.

(*b*) *Honorary Officers.*—It was unanimously agreed that Mr. V. Jobson be elected chairman. It was also agreed that the chairman, Mr. P. H. Wilson, Mr. J. K. N. Davis and Mr. G. W. Allott, with a representative of the heavy industry, to be added later, form an Executive Committee, and that Mr. J. G. Pearce be appointed secretary.

The Executive Committee, since then, have obtained the co-operation of Ley's Malleable Castings Company, Limited, and Mr. Francis Ley, their managing director, has been co-opted to the Executive.

It should be fully understood that the I.N.C. is entirely an emergency organisation, and that it does not intend to deal with questions outside those relating to castings, and that it is entirely non-sectional.

The Executive Committee have met the Controller of Iron and Steel, and have been informed that the Iron and Steel Control would be agreeable to regarding the I.N.C. as representing and acting for the industry as a whole, on the understanding that it should function regardless of individual interests.

Arising out of the above meeting, it was obvious that if the industry is to be of the hoped-for assistance to H.M. Government, the activities as originally envisaged may have to be enlarged.

It will be seen, from the list of those present at York, that strong support that has been received for the course which is being pursued, and in order that the Committee may speak with a completely united voice, it will be glad to know that foundry concerns support the action taken, and that the Committee referred to should represent the industry for the purposes mentioned.

List of Firms and Bodies Represented.—Qualcast, Limited (Mr. V. Jobson); National

(*Continued in previous column.*)

(*Continued from next column.*)

Ironfounding Employers' Federation (Mr. J. D. Carmichael); Ashmore, Benson, Pease & Company, Limited (Mr. N. E. Rambush); International Meehanite Metal Company, Limited (Mr. N. E. Rambush); Radiation, Limited (Mr. J. K. N. Davis); Radiation, Limited (and Pig Iron Users' Association) (Mr. F. Bowen, for Dr. Harold Hartley); Newton, Chambers & Company, Limited (Mr. G. W. Allott); Midland Ironfounders' Association (Mr. A. E. Hurst); Institute of British Foundrymen (Mr. T. Makemson); Smith, Patterson & Company, Limited (Mr. R. O. Patterson); Stanton Ironworks Company, Limited (Mr. P. H. Wilson); Federated Foundries, Limited (Mr. J. H. Deas); Allied Ironfounders, Limited (Mr. J. Shaw); British Ironfounders' Association (Mr. J. G. Sneddon); Yates, Haywood & Company (Mr. A. P. Harrop); Carron Company (Mr. A. W. Honeyman); and the British Cast Iron Research Association (Mr. J. G. Pearce).

Basic Electric Practice for Steel Castings

By CHARLES W. BRIGGS

(*Concluded from page 271.*)

A fluid basic refining slag will lower the sulphur content of the metal appreciably. It is not uncommon to obtain a sulphur content in the neighbourhood of 0.010 per cent. after good refining conditions have been maintained. In Table VII are listed a few analyses showing sulphur percentages present in the metal both before and after the refining period.

TABLE VII.—*Percentage of Sulphur Present in Metal Before and After Refining Periods.*

	1.	2.	3.	4.	5.
Before refining ..	0·038	0·042	0·044	0·030	0·062
After refining	0·013	0·023	0·014	0·008	0·029

Reductions in the neighbourhood of 0.10 to 0.01 per cent. sulphur require the extension of the refining periods to much longer periods than that usually given in normal operation or require a slag containing 2.00 to 3.00 per cent. calcium carbide throughout the refining period. With large percentages of calcium carbide present in the slag, the sulphur will be quickly eliminated.

Constant attention must be given to temperature control in electric furnace steel production, since the equilibrium between oxygen in the bath and in the slag changes materially with temperature. Hydrogen is also more likely to be absorbed at higher temperatures; this is particularly serious when certain of the chromium-nickel steels are being melted, especially those containing considerable silicon. Hydrogen causes porosity in castings; consequently, every effort should be made to maintain an atmosphere of carbon monoxide in the furnace, especially during the elimination of sulphur which requires a high temperature for efficient elimination.

Petrographic analysis of a carbide slag indicates the presence of dicalcium-silicate ($2CaO.SiO_2$) and usually tri-calcium silicate ($3CaO.SiO_2$), a small amount of solid-solution phase consisting of magnesium oxide, manganese oxide and ferrous oxide, undissolved magnesium oxide, and possibly some free lime.

Single-Slag Process

The single-slag process is used in many cases when the phosphorus content of the scrap is less than 0.04 per cent. One foundry reports that the majority of its scrap contains less than 0.035 per cent. phosphorus, and hence they always use the single-slag operation.

The single-slag procedure, of course, speeds up the practice since the deoxidation or refining period can proceed as soon as the charge is melted. This results in bringing the production time more in line with the acid electric practice, which is a single-slag process, with the added feature that the steel is more thoroughly deoxidised and the sulphur content may be materially reduced. If such features are important in the production of quality steel, then it is logical to propose that the single-slag basic practice offers distinct advantages over the acid electric practice.

The charging and melting methods are identical to those already described under the double-slag process, except that by the time melting is complete a slag of the proper volume and consistency for the refining conditions has been produced.

As soon as melting is complete, the bath is recarburised with a low-phosphorus pig-iron and pulverised carbon additions are made to the slag as has previously been discussed under the double-slag process. Since there are no outstanding differences in the refining practice of the two operations, it is reasonable to expect the same degree of desulphurisation in the single-slag method as was obtained in the double-slag operation. There is no phosphorus elimination, of course, since all the phosphorus oxide formed during the melting-down stage is reduced under the carbide slag of the refining period.

Typical finishing slags as used in the single-slag method are illustrated in Table VI (published last week). Slag No. 5 is high in iron oxide. Some producers maintain that this is necessary for a steel with good fluidity requirements, since it is reasoned that because of the equilibrium conditions between the metal and the slag a higher FeO content in the slag will produce a higher FeO content in the metal, and hence a greater fluidity is obtained. This is true providing a sufficient length of time is allowed for the equilibrium to take place. In the short period of 30 to 45 min. in which the refining slag is active, the equilibrium conditions are seldom, if ever, reached, and hence a slag containing 0.75 per cent. FeO may show as much FeO in the metal as a slag containing 2.50 per cent. FeO. This, of course, depends on the rate that FeO is reduced from the slag. It also should be pointed out that the FeO content (in the metal) at which maximum fluidity is obtained is not as yet known. It is, however, known that too much FeO in the metal is not conducive to good fluidity.

A furnace chart of a commercial single-slag heat is presented in Table VIII for study and comparison with the double-slag practice of Table IV. The slag analysis clearly points out the trend in the return of the phosphorus to the metal. It also shows the drop that takes place in the CaF_2 content after the single addition of fluorspar early in the refining part of the heat.

TABLE VIII.—*Record of a Single-Slag* Heat of a 3-ton Furnace.*

Analysis desired: C 0·25 per cent., Mn 0·60 per cent., Si 0·30 per cent., P less than 0·04 per cent., S less than 0·04 per cent.

Charge:	Misc. scrap low phos. 5,000 lbs., foundry returns 3,000 lbs. Total, 8,000 lbs.
3.30 p.m.	Power on high voltage.
4.00 p.m.	Lime 50 lbs.
4.30 p.m.	Lime 50 lbs.
5.00 p.m.	Lime 75 lbs.
5.30 p.m.	Lime 50 lbs.
5.45 p.m.	Melted down—First laboratory test for C and Mn.
5.48 p.m.	No. 1 slag test.
5.50 p.m.	Add: Ferro-manganese—40 lbs.; 80 per cent. Mn.
5.55 p.m.	Add: Wash metal—230 lbs.; 3·50 per cent. C.
5.58 p.m.	Add pulverised carbon—10 lbs. Low voltage.
6.00 p.m.	Report first test C 0·12 per cent., Mn 0·13 per cent.
6.05 p.m.	Add fluorspar 25 lbs.
	Add pulverised carbon 10 lbs.
6.13 p.m.	No. 2 slag test—faint acetylene odour.
6.15 p.m.	Second laboratory test for C and Mn.
6.15 p.m.	Pulverised carbon 5 lbs.
6.20 p.m.	No. 3 slag test—strong odour of acetylene.
6.25 p.m.	Pulverised carbon 5 lbs.
6.25 p.m.	Temperature test—intermediate voltage.
6.27 p.m.	Slag crumbles to white powder.
6.30 p.m.	Report second test C 0·20 per cent., Mn 0·45 per cent.
6.30 p.m.	Add wash metal 90 lbs., 3·50 per cent. C.
6.35 p.m.	Add ferro-manganese 11 lbs., 80 per cent. Mn.
	Add ferro-silicon 60 lbs., 50 per cent. Si.
6.40 p.m.	Stir bath; temperature test.
6.42 p.m.	No. 4 slag test.
6.43 p.m.	Tapped.

Ladle analysis: C 0·25 per cent., Mn 0·62 per cent., Si 0·30 per cent., P 0·035 per cent., S 0·020 per cent.

* The corresponding slag analyses for the single slag heat are given in Table IX.

An indication of the amount of phosphorus that is eliminated in a single-slag heat may be obtained from the phosphorus analyses of the heat recorded in Table VI. A sample taken just at the time of melt-down showed 0.038 per cent. phosphorus, whereas the ladle analysis gave 0.035 per cent. phosphorus, or a reduction of only 0.003 per cent.

Hot-Metal Process

The hot-metal process obtains its name from the fact that the steel is melted in some other furnace, usually the basic open-hearth furnace, and then transferred to the basic electric furnace for the refining treatment. The furnaces used in the hot-metal process have rated capacities of from 7 to 10 tons, and the bottom lining is usually sintered magnesite. The hot-metal charge may come directly from the open-hearth or it may consist of the end of an open-hearth heat, such as, for example, a casting floor being poured off and the metal remaining in the ladle transferred to the basic electric furnace. The open-hearth slag as well as the metal is charged.

The current is turned on, the molten charge heated, and the slag worked to the proper consistency and volume comparable with that of an oxidising slag. The slag may contain a higher FeO content than is normal in most basic electric oxidising slags, but this is because of the high iron oxide content that is carried by an open-hearth slag. One operator using the hot-metal process reported an FeO content of 40.76 per cent. present in the oxidising slag.

Time is allowed for phosphorus reduction before the oxidising slag is removed. Steel as produced in the basic open-hearth will normally contain phosphorus in amounts between 0.015 and 0.025 per cent. These values may be further reduced in the oxidising period of the basic electric furnace. Following the slagging-off operation the heat proceeds in the same manner as recorded in the double-slag process.

The hot-metal process may be successfully carried on in a shop having several open-hearth furnaces wherein open-hearth metal is supplied to an electric furnace to produce a small tonnage of high-grade steel, which may be tapped at a high temperature for the production of small castings.

Alumina Slag Modification of the Double-Slag Process

A modification of the double-slag process has been devised, wherein aluminium is used in place of carbon to obtain a reducing slag. This type of slag finds its greatest application in stainless steel or other alloys where it is desired to maintain the carbon content in the metal at a low figure. The method has equal application to carbon steels and low alloy steels. The melting and oxidising stages are similar to those used in the double-slag or single-slag practice. A furnace record using aluminium additions to the refining slag is given in Table IX.

There are certain unusual features exhibited by this practice, one of which is the addition of ferro-silicon before the first slag is removed. The reason for this was not determined. From the standpoint of phosphorus removal it would seem to be better to add it after the slag had been removed. The large amount of ferro-silicon and ferro-manganese added during this period was for the purpose of killing the bath. The refining is then carried out on a killed bath.

Lime should be mixed with the aluminium so that it may be spread more evenly over the bath and to prevent the slag from becoming too fluid. Analyses of the metal have shown that there

is no aluminium pick-up. The steel foundry using this slag regularly states that the metal can be shanked if necessary. A study of the alumina slag process on a semi-commercial scale in a 500 lbs. per hr. rated capacity furnace produced the slags shown in Table XI on a carbon-steel heat. The elapsed time between the placing of the refining slag and the taking of the slag sample is recorded. It has been suggested that the alumina slag proved an excellent type of slag to carry on stainless and corrosion-resistant steel. The furnace chart for a stainless steel heat, wherein the alumina slag is used, is reproduced in Table XII.

Table IX.—*Slag Analyses for Single-Slag Heat of Table VIII.*

	Oxidising	Refining slags		
	No. 1. 5.48 p.m.	No. 2. 6.13 p.m.	No. 3. 6.20 p.m.	No. 4. 6.42 p.m.
CaO ..	51·20	46·09	49·61	53·55
CaF_2 ..	0	7·39	4·46	3·40
CaS ..	0·32	0·41	0·44	0·52
CaC_2 ..	0·09	3·13	4·62	2·88
FeO ..	14·85	3·02	1·02	0·56
MnO ..	5·52	3·53	1·31	0·61
Al_2O_3 ..	2·94	2·89	3·00	2·82
MgO ..	7·76	8·40	8·62	9·09
Cr_2O_3 ..	0·57	0·16	0·06	0·02
P_2O_5 ..	0·47	0·33	0·16	0·07
CiO_2 ..	15·39	25·86	26·35	26·60
Colour ..	Black	Brown	Grey	White

Table X.—*Furnace Record Double-Slag Heat—Alumina Slag Modification.*

Analysis desired: C 0·30 to 0·35 per cent., Mn 0·55 to 0·65 per cent., Si 0·30 to 0·40 per cent., P and S less than 0·03 per cent.

Charge:

Molybdenum foundry scrap 9,000 lbs.(0.5 per cent. Mo)
Plate scrap .. .. ..7,000 lbs.
Calcium molybdenum .. 84 lbs. (40 per cent. Mo)
Limestone .. .. .. 400 lbs.

1.00 p.m. Current on.
2.00 p.m. Lime 200 lbs. added.
2.45 p.m. Iron ore added 150 lbs.
2.50 p.m. Heat melted.
2.55 p.m. Laboratory test for carbon—Reported C 0·15 per cent.
3.15 p.m. Laboratory test for Ni and Mo—Reported Ni 0·15 per cent., Mo 0·56 per cent.
3.30 p.m. Addition—FeSi 40 lbs., Si 50 per cent.
3.35 p.m. Slag off.
3.38 p.m. To open bath add FeMn 40 lbs., Mn 80 per cent.; FeSi 40 lbs.; 12 lbs. coal.
3.40 p.m. Slag materials mixed and added: 400 lbs. lime, 75 lbs. fluorspar. 20 lbs. ground coke.
3.45–4.25. Added 200 lbs. of lime, and 60 lbs. of aluminium shavings added.
3.55 p.m. Laboratory test for C and Mn—Reported C 0·21 per cent., Mn 0·38 per cent.
3.55 p.m. Slag test No. 1.
4.10 p.m. Add 24 lbs. FeMn and 275 lbs. pig-iron.
4.15 p.m. Add 53 lbs. FeSi (50 per cent. Si).
4.25 p.m. Add 20 lbs. FeTi (40 per cent. Ti).
4.30 p.m. Slag test No. 2.
4.35 p.m. Tapped.

Ladle Analysis: C 0·32 per cent., Mn 0·57 per cent., Si 0·37 per cent., P 0·024 per cent., S 0·017 per cent., Mo 0·60 per cent., Ti 0·16 per cent.

Mechanical properties:—

Annealed at 900 deg. C.

Tensile strength .. .. 34·7 tons per sq. in.
Yield strength .. .. 20·4 tons per sq. in.
Reduction of area.. .. 45 per cent.
Elongation.. .. .. 27·5 per cent.
Bend .. .. .. 120 deg.

Refining slag.	No. 1—3.55 p.m.	No. 2—4.30 p.m.
CaO	55·70	46·44
CaF_2	9·06	4·86
CaS	0·39	0·57
CaC_2	1·66	0·22
FeO	0·62	0·51
MnO	0·77	0·34
Al_2O_3	8·90	12·24
MgO	8·69	15·84
SiO_2	12·62	18·34
TiO_2	—	0·86
Colour	Green to white	White

Alloy Steel Production

There is very little difference in the process between carbon steel practice and low alloy content steels. In the case of nickel, copper or molybdenum steels, a large portion of the nickel, copper and the calcium-molybdenum is charged with the scrap. Melting is carried on as rapidly as possible, and from time to time lime or limestone is added to make up the slag to the proper consistency. If iron ore is needed, it is added at the time that the scrap is completely melted. As soon as the boiling action from the ore has subsided, the oxidising slag is removed. The usual refining slag is placed on the bath and reducing conditions are maintained. Alloys such as chromium and manganese are not added until a carbide slag is obtained. In case of large additions of alloys, care should be taken not to add too much at one time, as the bath will be chilled and extra lime will be required for melting. After additions of alloys the bath should be thoroughly stirred before samples are taken for analyses.

Table XI.—*Alumina Slag on 1,100 lbs. Carbon-Steel Heat (Refining Slags).*

	Elapsed time.*				
	No. 1. 15 min.	No. 2. 25 min.	No. 3. 40 min.	No. 4. 60 min.†	No. 5. Ladle.‡
CaO ..	45·83	50·61	57·87	59·53	54·50
CaF_2 ..	7·24	5·01	3·04	1·45	0·02
CaS ..	0·26	0·48	0·50	0·57	0·55
CaC_2 ..	0·11	1·73	0·73	0·29	0·19
FeO ..	10·70	0·93	1·07	0·93	1·27
MnO ..	5·87	0·66	0·66	0·39	0·75
Al_2O_3	1·34	14·43	12·32	11·58	10·92
MgO ..	10·26	8·98	8·84	9·03	10·74
Cr_2O_3	0·33	0·03	0·03	0·02	0·01
P_2O_5 ..	0·45	0·10	0·10	0·07	0·03
SiO_2 ..	16·66	14·08	13·30	14·20	18·86
Total ..	99·05	97·04	98·46	98·06	97·84

* Time elapsed between addition of refining slag and the slag sample.
† 5 min. before tapping, just prior to addition of Fe-Si, Fe-Mn, Fe-Ti
‡ Slag taken from the ladle during pouring.

Table XII.—*Furnace Record 18:8 Cr-Ni Heat—Alumina Slag.*

Analysis desired: C 0·06 per cent., Mn 0·50 to 0·60 per cent., Si 0·30 to 0·50 per cent., Ni 8 to 9 per cent., Cr 17·5 to 18·5 per cent., S less than 0·025 per cent., P less than 0·025 per cent.

Charge: 2,000 lbs. common scrap, 245 lbs. nickel.

3.30 p.m. Current on high voltage.
4.00 p.m. Add lime 20 lbs.
4.45 p.m. Add lime 30 lbs.
5.15 p.m. Melt down low voltage.
5.20 p.m. Add iron ore 50 lbs.
5.35 p.m. Stir bath—Laboratory test for C. Carbon reported 0·03 per cent.
5.50 p.m. Slag off.
5.55 p.m. Add FeSi 10 lbs., 75 per cent. Si.
5.55 p.m. Add slag mix: 50 lbs. lime. 5 lbs. pulverised FeSi 5 lbs. fluorspar.
6.10 p.m. First test reported P 0·015 per cent., Ni 11·25 per cent.
6.20–7.15. Add lime 20 lbs., 10 lbs. aluminium.
6.35 p.m. Slag tests—White slag test for Mn.
6.40 p.m. Add ferro-chromium, 300 lbs., 0·06 per cent. C, 70·5 per cent. Cr, 0·70 per cent. Si.
6.55 p.m. Report on Mn 0·10 per cent.
7.10 p.m. Add ferro-chromium 215 lbs.
7.25 p.m. Add Fe-Mn 11 lbs., 85 per cent. Mn. Add Fe-Si 2 lbs., 76 per cent. Si.
7.27 p.m. Add Fe-Ti 4 lbs., 40 per cent. Ti.
7.30 p.m. Tapped.

Ladle analysis: C 0·06 per cent., Mn 0·55 per cent., Si 0·36 per cent., P 0·014 per cent., S 0·014 per cent., Ni 8·21 per cent., Cr 17·90 per cent.

Tapping slag: CaO 59·09 per cent., CaF_2 2·05 per cent., CaS 0·41 per cent., CaC_2 0·09 per cent., FeO 0·62 per cent., MnO 0·26 per cent., Al_2O_3 19·54 per cent., MgO 5·12 per cent., Cr_2O_3 0·41 per cent., P_2O_5 0·03 per cent., SiO_2 11·21 per cent., TiO_2 0·76 per cent.

Stainless steel is seldom made under a carbide slag and if the alumina slag is not used, then pulverised ferro-silicon is added to the slag to bring about reducing conditions. If stainless steel scrap is melted, only the single-slag process is used.

High-manganese steel (12 to 14 per cent.) is always produced in the basic electric furnace. The furnace bottom is composed of magnesite that is sintered in place. Only the single-slag process is used in the production of 12 to 14 per cent. manganese steel [in the U.S.A.]. A definite melting procedure based mainly on the power input is followed for all heats. The melting time will average about 60 per cent. of the total time for producing a heat. Lime is added to the bath during the melting period.

After melting, the bath will contain approximately 0.90 to 1.00 per cent. carbon, 11 per cent. manganese and 0.30 per cent. silicon. The slag at melt-down will consist of approximately CaO 50 per cent., SiO_2 20 per cent., FeO 3 per cent. and MnO 10 to 15 per cent., if a good basic slag is maintained. In some cases very little lime is added to the bath during the melt-down period. In this case, a slag is obtained approximately as follows: CaO 10 per cent., SiO_2 30 per cent., FeO 3 per cent., and MnO 40 per cent.

As soon as melting is complete, the slag is deoxidised with pulverised coke. Spar is generally used for getting the slag to the proper consistency if it is too viscous. A strong carbide slag is not often desired. One manufacturer says, "We go right up to a carbide slag, without obtaining it. We try to avoid it." A typical finishing slag under the above processing is as follows: CaO 58.66 per cent., SiO_2 24.01 per cent., FeO 0.42 per cent., and MnO 1.01 per cent. Ferro-silicon is used as a degasifier.

In another method of making high-manganese steel, neither carbonaceous material nor pulverised ferro-silicon is used to deoxidise the slag. The reason for this is that it is claimed that the amount of manganese recovered by using such a practice will not pay for the time or material used. Also, the mechanical properties do not appear to be improved by the reduction process. A finishing slag under such a practice would consist of 12 per cent. CaO, 30 per cent. SiO_2, 30 per cent. MnO, 20 per cent. MgO and 2 per cent. Al_2O_3. Metal produced under a slag of this type can be shanked all over the shop.

Deoxidisers and Degasifiers Used in the Basic Process

Basic electric steel is degasified with ferro-silicon and ferro-manganese. These additions also deoxidise small amounts of FeO and MnO in the metal. These alloys are usually added from 5 to 15 min. before tapping. In some cases, ferro-titanium is added to the bath about 5 min. before tapping. An amount of 0.05 per cent. titanium constitutes the normal addition. Titanium appears to have excellent degasifying powers and is a stronger deoxidiser than manganese or silicon, but not as strong as aluminium.

Table XIII.—*Properties Obtained on Cast Test Coupon Annealed at 900 deg. C.*

Chemical analyses.		Physical properties.	
C ..	0·27	Tensile strength	33·5 tons per sq.in.
Mn ..	0·63	Yield point ..	21·4 tons per sq. in.
Si ..	0·29	Elongation ..	28 per cent.
S ..	0·02	Reduction of	
P ..	0·02	area	46 per cent.

Aluminium is used in some cases as a final deoxidiser with the addition being made to the ladle. Low-ductility troubles arising from aluminium additions are not encountered when critical amounts of 1 lb. per ton are added. This is due probably to the fact that the sulphur

SHALAGO (highest in Carbon)
COAL DUST
PARTING POWDER
TERRA FLAKE
BLACKLEAD and
FOUNDRY REQUISITES

•

The Cumming
FURNACE
Melts Brass in 15 minutes

•

The Cumming
HAND RAM
MOULDING MACHINE

•

The Cumming
ELECTRIC RIDDLE

•

Head Office and Works—
KELVINVALE MILLS,
MARYHILL, GLASGOW.

FOUNDRY BLACKINGS

•

PLUMBAGO
IMPORTED DIRECT FROM CEYLON

•

CUMMING CORE
COMPOUNDS

•

CORE GUM
CUMMINGUM

•

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IRONFOUNDERS' FACINGS MANUFACTURERS & GENERAL FOUNDRY FURNISHERS

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content in the basic process is usually 0.02 per cent. or below, which amount is not sufficient to form an extensive network of sulphide inclusions.

Mechanical Properties

Steel of excellent mechanical properties can be obtained by the use of the basic electric process of steelmaking. The properties illustrated in Table XIII are typical of those obtained on separately cast test coupons, annealed at 900 deg. C.

REACTIONS IN THE BASIC ELECTRIC PROCESS

Reactions of Oxidation

When steel is melted in the basic electric furnace, it is subjected to certain chemical reactions that are primarily oxidising. These reactions may be considered to take place in three distinct steps:—(1) The oxidation and elimination of silicon and manganese; (2) the oxidation and elimination of phosphorus; and (3) the oxidation, and hence the elimination, of carbon.

The silicon and manganese in the charge are oxidised by iron oxide, which is introduced with the scrap as rust or scale, or by additions of iron ore during the melting period. The oxidation proceeds according to the following reactions:—

$$2\,FeO + Si \rightarrow SiO_2 + 2\,Fe$$
$$FeO + Mn \rightarrow MnO + Fe$$

The rate at which reactions proceed would indicate that all of the silicon should be oxidised before the manganese reaction may take place. In commercial practice, however, this does not hold true, since the manganese is oxidised nearly as rapidly as silicon. It does not, however, attain the low figure that is usually recorded by silicon. Silicon will be oxidised to residual values of 0.04 per cent. or less, whereas it is increasingly difficult to bring the residual manganese content below 0.10 per cent.

During the process of silicon and manganese oxidation, the SiO_2 combines with FeO to form a ferrous silicate which reacts with the lime slag to form a more stable calcium silicate, thus freeing the FeO which migrates into the molten bath and is thus available for the oxidation of other constituents. The MnO also combines with SiO_2, forming a manganese silicate which is much more stable than ferrous silicate and, hence, is retained as such in the slag.

It should be added that if vanadium or chromium is present in the charge, these elements will likewise be oxidised. These elements are oxidised concurrently with manganese and silicon. Chromium, on the other hand, reacts somewhat like manganese in that, although rapid oxidation is recorded at first, it becomes increasingly harder to oxidise it as the residual percentage becomes less.

The oxidation and removal of phosphorus from the bath apparently depend on three variables:—(1) An excess of oxygen; (2) a very basic slag; and (3) a low temperature. According to Sisco,* the elimination proceeds by the formation of phosphoric acid, ferrous phosphate and finally as calcium phosphate, in the following manner:—

$$5\,FeO + 2\,Fe_3P \rightarrow P_2O_5 + 11\,Fe$$
$$3\,FeO + P_2O_5 \rightarrow (FeO)_3 + (P_2O_5)$$
$$(FeO)_3\,(P_2O_5) + 3CaO \rightarrow (CaO)_3\,(P_2O_5) + 3\,FeO$$

The phosphoric acid is, of course, very active and immediately upon forming it will react with iron oxide, which is always present in the oxidising slag in large amounts, and form ferrous phosphate. Calcium oxide is a much stronger base than ferrous oxide; hence, CaO replaces the FeO to form calcium phosphate which is relatively stable in a very basic slag. Experiments have shown, however, that, although calcium phosphate is a stable compound, calcium silicate is more stable. Thus, so long as there is either silicon in the metal or uncombined silica in the slag, it will react with the calcium phosphate, setting free phosphoric acid and exposing it to possible reduction to iron phosphide. It thus becomes apparent that if phosphorus is to be eliminated, the slag must contain an excess of bases in order that all silica may be combined as calcium silicates, so that the stable calcium phosphate may be formed.

It is generally conceded that the oxidation of phosphorus proceeds more efficiently at low temperature, since at the higher temperature carbon oxidises in preference to the phosphorus. The oxidation of carbon takes place according to the following reaction:—

$$FeO + Fe_3C \rightarrow 4\,Fe + CO$$

The amount of carbon that is eliminated depends entirely upon the amount of iron oxide in the charge. Silicon and nearly all the manganese and phosphorus are oxidised before the oxidation of the carbon becomes active. If only a small percentage of iron oxide remains, the carbon oxidation will be low and the carbon content in the bath will be in the neighbourhood of 0.20 per cent. This is true when steel is being produced for steel castings, since the original carbon content of the scrap will seldom average over 0.35 per cent. carbon when melting with restricted oxidation.

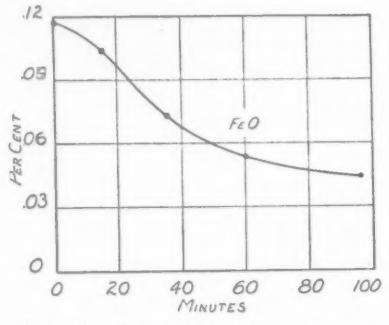

Fig. 1.—Iron Oxide Elimination in Basic Electric Heat During Refining Period of an 0.18 per cent. Carbon Steel.

High iron-oxide content results in complete oxidation of the carbon, thus resulting in the production of a low-carbon steel. While this is a disadvantage from the standpoint that the bath becomes practically saturated with FeO, thus requiring thorough refining, it is a practice which produces the highest mechanical properties. It has previously been stated that there is a small amount of desulphurisation in the oxidation period. Authorities differ as to the reactions that take place. Apparently the sulphur in the form of manganese sulphide reaches the slag where it is converted into calcium sulphide.

Reactions of Deoxidation

The general reaction of deoxidation is:—

$$3\,FeO + CaC_2 \rightarrow CaO + 2\,CO + 3\,Fe$$

If aluminium is used, the reaction is:—

$$3\,FeO + 2\,Al \rightarrow Al_2O_3 + 3\,Fe$$

Manganese oxide is likewise reduced according to similar reactions. The speed with which these reactions take place depends upon the rapidity with which the dissolved oxides in the bath reach the slag-metal interface. They also depend upon the amount of oxides that are present in the slag. The oxides in the slag soon reach a low figure after the reducing element is added to the slag. Since there is an equilibrium which exists between the ferrous and manganese oxides in the bath and in the metal, there is a migration of FeO and MnO from the metal to the slag in order to restore the equilibrium. A typical curve of iron oxide elimination from the bath under the reducing slag of the basic electric furnace of 6 ton capacity has been prepared by Herasymenko and Valenta* and is shown in Fig. 1.

This figure refers to a 0.18 per cent. carbon steel which did not require recarburisation before the reducing slag was formed. The diagram shows that the amount of iron oxide in the metal decreases rapidly at first. Towards the end of the heat, the rate of iron-oxide elimination becomes slower.

The minimum content of iron oxide which can be obtained in basic electric steel under good reducing slag is approximately 0.020 per cent. This value is considerably lower than the amount of dissolved iron oxide in acid steel, and thus basic electric steel is usually much cleaner.

Reactions in Desulphurisation

There appear to be several factors affecting the removal of sulphur. In order to obtain maximum sulphur elimination (1) the slag must be highly basic; (2) a reducing slag must be present; (3) the slag must be fluid and hot, and (4) the slag should contain additions of fluorspar. The principal desulphurising reactions appear to be:

$$2\,CaO + 3\,MnS + CaC_2 \rightarrow 3\,CaS + 2\,CO + 3\,Mn$$
$$CaF_2 + 2\,MnS + Si \rightarrow 2\,CaS + SiF_4 + 2\,Mn$$

A good refining slag will meet the above requirements for maximum sulphur elimination. Fluorspar is of great assistance in removing sulphur. By increasing the fluidity of the slag and thereby increasing its activity, it speeds up the reactions taking place; it also permits very basic slags to be employed which would otherwise be too viscous to be worked. Thus, fluorspar favours the removal of sulphur from the metal into the slag. It is also directly effective in removing sulphur by combining with it, forming a volatile sulphur-fluorine compound which passes out of the furnace.

Final Deoxidation and Degasification

Calcium carbide, although an efficient deoxidising agent, does not cause degasification. The reason for this, as stated by Sisco, "may be found in the fact that carbon monoxide gas is somewhat soluble in the molten bath, and as there is no migration of the dissolved gas from bath to slag, as is the case with dissolved ferrous and manganese oxide, the calcium carbide in the slag has no opportunity to react with it."

Besides CO, there are usually small amounts of hydrogen and nitrogen present which are also removed in part—probably by a mechanical action rather than by any chemical combination. If there is further manganese oxide or ferrous oxide present in the metal after the refining period, the manganese and silicon additions will reduce them to their respective metals.

Summary

The basic electric furnace practice as used in the manufacture of steel castings has been described, and the following subjects have been discussed in detail:—(1) Furnace linings and materials; (2) charging and melting; (3) double-slag practice (cold scrap); (4) single-slag practice (cold scrap); (5) hot metal charge practice; (6) alumina slag method; (7) manufacture of carbon and alloy steels by the basic process; (8) deoxidation and degasification, and (9) reactions of oxidation and reduction.

Acknowledgments

The author wishes to acknowledge with appreciation the assistance rendered him with regard to the presentation of information concerning the commercial practices as carried on throughout the country. Information was presented by: S. W. Brinson, Norfolk Navy Yard, U.S. Navy; K. S. Howard, General Steel Castings Corporation; A. G. Gierach, American Manganese Steel Division, American Brake Shoe Company; and D. L. Parker, General Electric Company.

* Sisco, F. T., Trans. Faraday Society, No. 62, vol. 21, Part 2, December, 1925.

* Herasymenko, P., and Valenta, E., Trans. American Foundrymen's Association, vol. 43, 1934, pp. 21-47.

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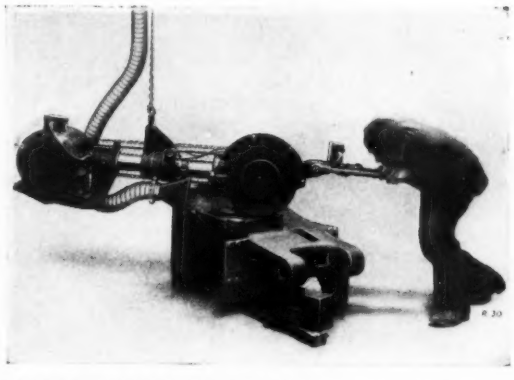

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The Week's News in Brief

Trade Talk

THE MIDLAND COUNTIES COKE ASSOCIATION have removed from 48, Corporation Street, to King Edward House, 135, New Street, Birmingham, 2.

THE MONOMETER MANUFACTURING COMPANY, LIMITED, have transferred their head offices to "Barton Towers," Clifton Drive, Westcliff-on-Sea, Essex

MAJOR T. RUSSELL CAIRNS was re-elected president of the North East Coast Institution of Engineers and Shipbuilders at the annual meeting at Newcastle-upon-Tyne on October 13.

THE ALUMINIUM RESEARCH LABORATORIES, at New Kensington, Pa., U.S.A., are being extended by the addition of 15,000 sq. ft., making a total of 71,000 sq. ft. of laboratory floor space.

THE UNITED MOLASSES COMPANY, LIMITED, of Lloyds Bank Chambers, Market Place, Hull, have now acquired temporary premises at 56, Newland Park, Hull (telephone No. 8641).

ACCORDING to the Penton List of American and Canadian foundries, 18 per cent. in the U.S.A. and 26 per cent. in Canada operate laboratories. The corresponding figures for patternshops are 61 and 68 per cent.

TWO EMPLOYEES at the steelworks of Messrs. Stewarts & Lloyds, Limited, Corby, Northants, have been killed within three days. One man was electrocuted while working near some high-tension cables, and the other died from injuries received when a crane jib fell on him.

THE INSTITUTE OF WELDING informs us that while it will be necessary to curtail the lecture programme to some extent, it is hoped that it will be possible to hold a number of meetings in London and the provinces for the presentation of reports or Papers to which publicity should be given. Arrangements on these lines will be made as soon as possible.

THE FORDATH ENGINEERING COMPANY, LIMITED, Hamblet Works, West Bromwich, inform us that their telephone numbers are now West Bromwich 0549 and 0540. Formerly the numbers were 0549 and 0550, but the number 0550 has been allotted to a private house. The attention of our readers is directed to this change of numbers.

MR. F. J. COOK, M.I.Mech.E., a Past-President of the Institute of British Foundrymen, has promised to address the opening meeting of the London Branch of the Institute, which is to be held at Charing Cross Hotel on Saturday, November 25, at 2 p.m. His subject is to be "Foundry Layout."

A RECORD of low level of unemployment for Clydeside engineers is reported by Mr. Harry Luckhurst, an official of the A.E.U. He states that the bulk of the unemployed members who are physically fit have obtained jobs. The district committee has agreed to the relaxation of the overtime agreement where it is reasonable and necessary.

MR. L. TAVERNER, Assistant Professor of Metallurgy, was congratulated by the Council of the University College of Swansea, presided over by Sir George L. Barstow, last week, on his appointment as Professor of Metallurgy and Assaying at the Witwatersrand University and Director of the Government of South Africa Mineral Research Laboratory, from January 1, 1940.

AT THE ANNUAL MEETING of Parnall Aircraft, Limited, it was stated that Magnal Products, Limited, a subsidiary formed to safeguard the company's supplies of magnesium and other light alloy castings, although production only commenced six months ago, now supplied a large percentage of magnesium and aluminium castings to their main factories. Its attendant machine shop would also soon be in full production.

THE Council of the Institution of Electrical Engineers has decided that as many as possible of the activities of the Institution should be carried on as usual during the war, and that the library and headquarters of the Institution should remain for the time being in the present building at Savoy Place, London, W.C.2. Instead of meetings, a complete list of the Papers that were to have been read will be issued to members at the end of October, intimating that advance copies can be obtained on application to the secretary.

THE EIRE MINISTER FOR SUPPLIES announces in reply to trade queries that Irish firms are in a position to supply at reasonable prices the requirements of the country in the types of agricultural machinery and raw materials of the agricultural industry which are liable to customs duties or import restrictions. This position would be altered should a shortage of supplies of raw materials for the industries concerned occur at any time, but in such an event he was prepared to consult with the Minister for Finance to see what arrangements could be expeditiously made to permit the importation of any balance of manufactured goods required to maintain normal supplies. In the circumstances he did not think it necessary to recommend the Government to suspend tariffs and quotas on agricultural machinery and raw materials of the agricultural industry which were liable to customs duties or import restrictions.

Personal

MR. PAUL H. DURRANS, a director of James Durrans & Sons, Limited, Phœnix Works, Penistone, is yet another member of the Institute of British Foundrymen who is now on active service.

MR. H. BULL, the honorary secretary of the Scottish Branch of the Institute of Metals, who was very largely responsible for the organisation of the autumn meeting which was to have been held in Glasgow last month, has been presented by the Council with a suitably engraved silver salver.

MR. G. E. BAILEY (a director of the Metropolitan-Vickers Electrical Company, Limited), Mr. H. N. Sporborg (a director of the British Thomson-Houston Company, Limited), and Mr. P. S Turner (a director of Metropolitan-Vickers Electrical Company and assistant to the managing director of Associated Electrical Industries, Limited), have been elected directors of Associated Electrical Industries, Limited. Mr. P. S. Turner has also been appointed a member of the executive committee of the board of Associated Electrical Industries, Limited.

Wills

STOTT, V. H., managing director of James Stott & Company (Engineers), Limited, Oldham	£40,783
BISHOP, WILLIAM, of Harborne, for many years associated with Stewarts and Lloyds, Limited	£11,860

Obituary

MR. JOHN HERBERT WEBSTER, chairman and joint managing director of King, Taudevin & Gregson, Limited, Sheffield, died at his residence in Sheffield on October 22.

MR. G. HORSEMAN TODD, for many years assistant secretary and acting financial controller of Pease & Partners, Limited, Darlington, has died at his home at Darlington, aged 65. He served with Pease & Partners for 45 years and retired in 1936.

MR. ALBERT BYWATER MIDDLETON, a well-known Sheffield metallurgist and director and secretary of Flockton, Tompkin & Company, Limited, crucible steel makers, Attercliffe, died on October 16. Mr. Middleton, who was 65, had been a member of the firm all his working life.

MR. WILFRED ARTHUR MATTHEWS, formerly chairman and managing director of Turton Bros. & Matthews, Limited, Sheffield, died recently at his home in London. His father was a former Mayor of Sheffield and Master Cutler, and his elder son, Sir Ronald Matthews, is chairman of the London & North Eastern Railway Company.

MR. OSCAR HARMER, director and general manager of Alfred Herbert, Limited, has died at Coventry. He was 90 years of age and had been associated prominently with Midland engineering all his working life. He first entered the employ of the Capewell Horse Nail Company, and then spent several years with Babcock & Wilcox, joining the firm of Alfred Herbert in 1897.

MR. JOHN HENRY FREEBOROUGH, who was associated with a number of companies in the Birmingham and Sheffield areas, has died at Sheffield at the age of 78. He was a director of the British Time Recorder Company, Limited; Metal Heat Treatment, Limited (chairman); Beeley Foundry Company, Limited; the Sheffield Ingot Casting Company, Limited, and other companies.

THE DEATH has occurred of Mr. Benjamin Irving, M.I.Mech.E., chairman of the board of directors of Andrew Barclay, Sons & Company, Limited, engineers, Kilmarnock. He was previously managing director of Sir W. G. Armstrong Whitworth & Company, Limited, Newcastle-upon-Tyne. Mr. Irving served his apprenticeship with the North British Locomotive Company, Limited, Glasgow, and later went as a draughtsman to Andrew Barclay, Sons & Company. Subsequently, in 1919 he was appointed commercial manager in the London office of Armstrong Whitworth, and several years later became general manager of the firm's works at Scotswood, Newcastle. In 1931 he was appointed to the board of directors, and ultimately became managing director.

MR. THOMAS MCKENNA, general secretary of the National Union of Blast-furnacemen, Ore Miners, Coke Workers and Kindred Trades, died at Middlesbrough on Friday, October 13. He was addressing a union meeting when he collapsed. Although only 63 years of age, Mr. McKenna had completed 40 years' service as a trade union official, and his achievements on behalf of the blast-furnacemen were an outstanding example of the success of peaceful methods in labour negotiations. At the age of 23 he first became an official of the Blast-furnacemen's Union. In 1905 he became president of the Cleveland and Durham Blast-furnacemen's and Cokemen's Association, and nine years later he was elected president of the National Federation of Blast-furnacemen. When the five unions were merged in 1921 Mr. McKenna was appointed general secretary, and that post he retained until his death. He negotiated the memorable agreement for the reduction of the blast-furnacemen's working week from 56 to 48 hours, and last year also succeeded in obtaining holidays with pay for the men. He was essentially a man of peace. He held that the strike was a barbarous weapon, and it was due to his influence in no small measure that the iron trade has enjoyed such long immunity from labour disputes.

Catalogues Received

Furnace Charging Machines. Three leaflets have been received from the Incandescent Heat Company, Limited, of Cornwall Road, Smethwick, Birmingham, each one of which describes and illustrates a different phase of furnace charging. The first one relates to a hand-operated machine, and a twin unit is shown serving a battery of "Equi-Radiant" furnaces installed at the works of National Enamels, Limited, of Greenwich. By coupling two chargers together to form one unit, rapid operation is effected, because if a new load is ready for charging on one pair of forks, the load under treatment can be withdrawn by means of the other pair and the new load charged with a minimum delay.

The second leaflet describes a hand-operated cantilever type of machine for handling heavier materials, and an illustration shows a machine loaded with a tank weighing 4 tons. The third one shows the electrified cantilever type, which in general speeds up the operation and reduces labour costs. The extensive reach of some of these machines is noteworthy.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Frederick Field & Sons (Redditch), Limited—Capital £2,000. Engineers, founders, etc. Director: A. T. Turner, 61, Evesham Street, Redditch.

Woodfield Hoisting & Manufacturing Company, Limited, Samudas Wharf, Manchester Road, Millwall—Capital £30,000. Ironfounders, manufacturers of cranes, hoisting machinery, etc. Directors: C. H. Woodfield.

Forthcoming Event

Institute of British Foundrymen

NOVEMBER 4.

Wales and Monmouth Branch:—Members' discussion, opened by F. G. Jackson, at University College, Newport Road, Cardiff, at 3 p.m.

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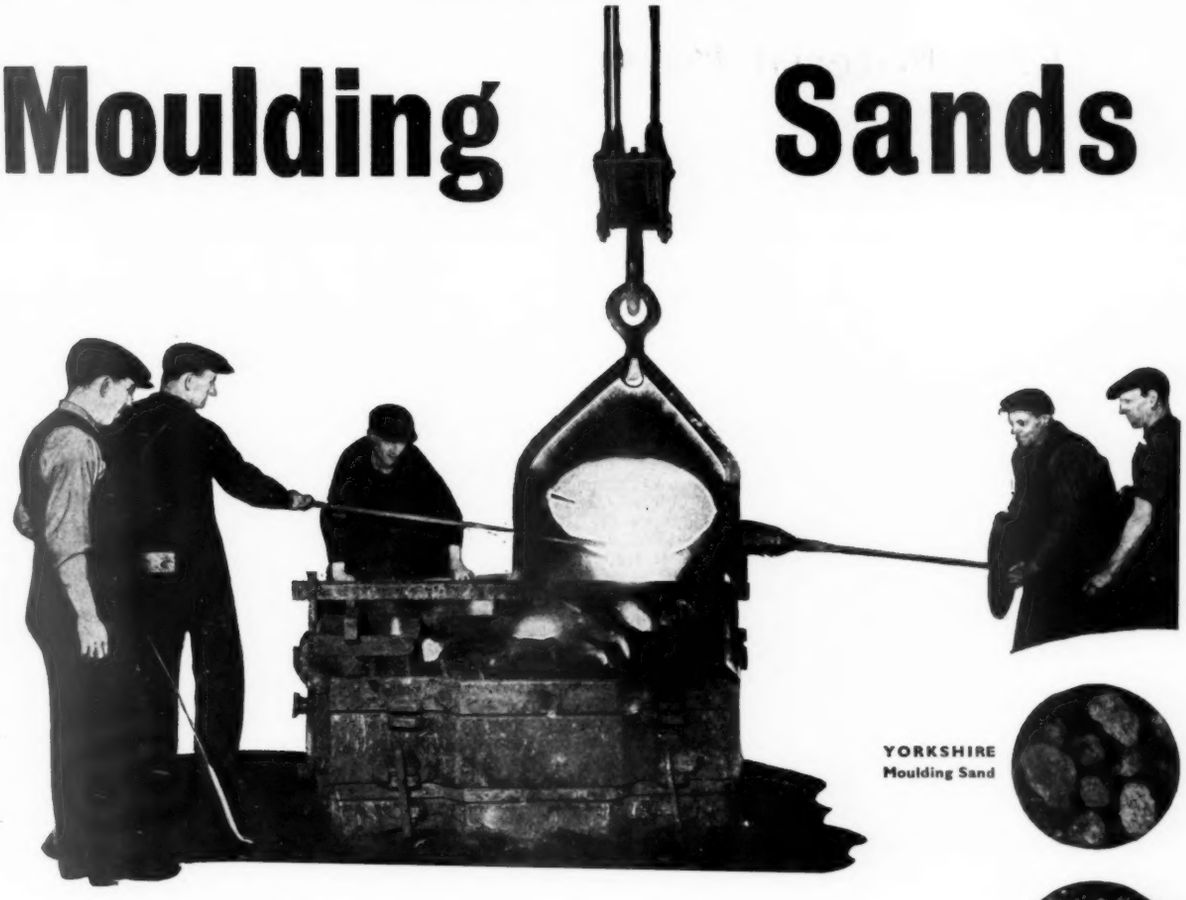
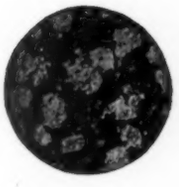
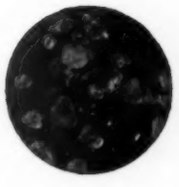


YORKSHIRE
Moulding Sand

THANET
Moulding Sand



YORK YELLOW
Moulding Sand



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Raw Material Markets

Although there is some difficulty still in procuring adequate supplies of low-phosphorus pig-iron, on the whole, supplies of iron are available in sufficient quantities to meet current requirements. It is now possible to import pig-iron from abroad duty free, but so far there has been little disposition to do so, as the costs involved are prohibitive unless the material is required urgently. In any case, most consumers have signed a loyalty agreement which does not allow them to buy foreign iron without losing the rebate which producers are prepared to give. Pre-war prices of low-phosphorus iron are expected to continue to operate for the time being, at any rate until October 31, after which the quotations for all types of iron and steel will come up for revision. An announcement with regard to the future trend of prices is expected to be made in the near future. If prices are advanced, as is expected, the difference between the old and the new levels will pass into a central pool. In this way all sections of the industry will contribute to the pool.

Pig-Iron

MIDDLESBROUGH—An early announcement in regard to prices ruling after the end of the present month is expected to be made. In existing circumstances, of course, the information is not of such pressing importance for the transaction of business. At the same time, business has fallen away to a considerable extent of late. More imported iron may be used by consumers in this area should prices be increased, as the difference between home and foreign prices will thus be reduced. At present Cleveland iron is obtainable at 94s. per ton, while the minimum offers of Belgian iron are at 100s., f.o.b. But supplies of local iron are ample as yet to meet all needs, though stocks have recently been lowered. The demand for hematite continues to be heavy; stocks have been drawn upon extensively of late, but supplies are still plentiful. Makers are fully booked up, and in the circumstances export business is rather neglected.

LANCASHIRE—Producers of pig-iron in this area have substantial tonnages booked, and the demand has been increased of late, through many consumers of scrap having to use pig in order to make good a deficiency in supplies of scrap metal. Many concerns in this area are directly or indirectly connected with Government work, and consumption of foundry iron is at a higher level than was the case before the outbreak of war. Speciality firms, particularly, report increased activity, and machine-tool makers and heavy electrical concerns are taking up large deliveries. Textile-machinery makers are also accepting iron more freely than was the case a few weeks ago.

MIDLANDS—Preferential consumers of pig-iron are receiving supplies satisfactorily, while other users are also obtaining material more freely than they did at the beginning of the war. There is some complaint that users of high-phosphorus iron are not always getting their usual grade, but under the existing conditions this is presumably unavoidable. Many foundries are now in a period of transition from domestic production to work of a national character, and when this is complete, consumption will no doubt be appreciably heavier. It is still rather difficult to obtain full requirements of low-phosphorus iron, but fair supplies are filtering through, while the position with regard to hematite is satisfactory, stocks being quite large at most manufacturers' works. When iron and steel prices are reviewed in the near future, it is anticipated that low-phosphorus iron quotations will be included in the control.

SCOTLAND—Delay in the despatch of pig-iron is fairly frequent, but deliveries are being made as quickly and as fairly as possible. It is expected that certain makers will shortly be in a position to expand their outputs, but nothing has yet been done in this connection. The position at light-castings foundries continues to be variable, some being much better placed for work than others. Steelworks continue to be in the market for heavy tonnages of hematite and basic irons; many are endeavouring to build up reserve stocks, but this is not easy at present.

Coke

Foundries' requirements of coke remain substantial, and many have placed orders involving deliveries up to the end of the year, which is in most cases as far ahead as collieries will go. Additional tonnages have been made available to home consumers as a result of a curtailment of exports. The present price is still a minimum of 50s. 6d. per ton, delivered Birmingham and Black Country stations, but most contracts are being made containing qualifying clauses in this respect.

Steel

The steelworks continue to operate at a very satisfactory level and the production of the industry is gratifying. The position is, in fact, improving and better deliveries to consumers are likely to be made in the near future. Users engaged on work of national importance are, of course, receiving the benefit of immediate deliveries, but others are also fairly well catered for and it is hoped that ordinary commercial requirements will be even better looked after in the future. Semi-finished steel for re-rollers is in heavy demand, and, although all requirements cannot be met without delay, consumers are being given every consideration

Scrap

A national campaign to encourage the recovery of scrap iron and steel was embarked upon on Monday by the Iron and Steel Control. A circular letter has been prepared and this week has been sent to manufacturers and industrial concerns, including undertakings which do not produce scrap in the ordinary course of their work but which may be able to contribute to the search for material with discarded machine parts or obsolete plant. Firms in the London area are being circularised this week, while next week the scheme will be applied to the Midlands and in succeeding weeks to other parts of the United Kingdom. In time the plan for recovering scrap will be applied also to householders. Obviously, the need for obtaining large tonnages of iron and steel scrap at the present time is very urgent and it is hoped that the co-operation of all concerned will have satisfactory results. The Control's letter emphasises that there is no scarcity of raw material for the steel furnaces, but it is necessary to look ahead. The heavier the supplies of home-produced scrap which become available the less strain will be imposed upon ocean transport for this purpose, while foreign exchange will also be saved. Meanwhile, there appears to have been an improvement in deliveries to consuming works since control prices were revised and the schedules were extended to include all descriptions. It is hoped that imports will shortly be on a larger scale, but foreign material is, of course, costlier and will only be used extensively in an emergency.

Metals

Members of the London Metal Exchange have been informed that the Ministry of Supply has approved proposals for the closing of open positions in copper, lead and spelter which have been outstanding since the commencement of the war. This announcement was made following prolonged discussions between representatives of the Government and the Exchange and has met with general approval on the Exchange, which has expressed its concern at the position which has prevailed from the first week of the war. Clients involved in these contracts will be asked to state whether they wish to take delivery of, or to deliver, as the case may be, metal at the contract prices. They will be given the alternative of selling or repurchasing the metal. The fixed maximum prices are £46 per ton for standard copper, £15 for spelter and £16 12s. 6d. for lead. Exchange members have been urged to solicit replies from clients by October 30, and on the following day it is proposed to hold a first settlement. If necessary, a further settlement will be held at a later date, as difficulties with regard to communications from clients in remote areas overseas may delay their replies.

The Ministry of Supply will take over unwanted metal and will also supply any deficency at the maximum prices. If necessary, members of the Exchange will be able to resume possession of stocks already offered to the Government, which is expected to have taken them over by October 31. The Ministry has redirected the attention of dealers to the general embargo on the export of copper, lead and zinc and emphasised that sales under licence can only be effected at or below the maximum prices fixed by the Government.

Copper—Most consumers of this metal continue to be very active and it is satisfactory to report that deliveries of copper are now quite good. The trade is settling down to new conditions brought about by the introduction of Control. Much has been heard of late from merchants, who contend that so far nothing has been done to allow them a commission, which they rightly claim would enable them to give better service to their regular customers. It is now understood, however, that the Metal Exchange is drawing up a scheme covering merchants' commissions. When this has received official sanction conditions in the trade will be much happier.

At a time when secondary copper is even more important to the economy of the nation than ever, satisfaction was felt at remarks made by Mr. George P. Joseph, chairman of Murex, Limited, at the annual meeting of the company, when he announced that the construction of the plant for the company's new copper refinery was in full progress and a considerable portion of the plant had been delivered and erected. Mr. A. Chester Beatty's remarks concerning the production of the Roan Antelope Copper Mines, Limited, at the annual meeting of the company, were also favourably received. He said that at the outbreak of war the company was producing at the rate of 5,753 tons a month; now the output was at 6,300 tons a month. He added that all necessary arrangements were being made by Empire producers to ensure that there would be adequate supplies of copper available during the period of hostilities.

Tin—The quantity of tin daily available for sale on the London Metal Exchange continues to be quite inadequate to meet all requirements, despite the fact that the executive of the buffer pool is providing a daily quota of 25 tons which is intended to satisfy the more urgent needs. A long waiting list is having to be considered by the Exchange's sub-committee for the distribution of the daily quota and some difficulty is experienced in deciding which applications deserve preferential satisfaction. This does not mean that tin requirements in this country are not being met. Nevertheless, stocks have been considerably reduced since the beginning of September. At the same time, licences continue to be supplied freely for export to the United States, and while profits attained thereby are doubtless very gratifying, it is felt that tin should not be despatched abroad at a time when supplies are required at home. American tinplate mills are currently operating at around 91 per cent. of capacity, which is the best figure for over two years.

The Arnhem (Holland) smelter continues to operate, but it is felt that it will have to close down shortly, the chances of obtaining adequate supplies of ore being remote. A ban has been placed on the export of tin by the Dutch Government, while the British Government, of course, regards tin ore and concentrates as contraband.

Spelter—Consumption of this metal continues to be heavy, but most users are obtaining adequate supplies. Interesting comment on the zinc situation was made by Viscount Horne at the annual meeting of the Imperial Smelting Corporation, Limited, on Thursday last. He said that he was hopeful that within the next three or four months their full programme of plant reorganisation would be completed, and that they would then be easily able to produce the 60,000 tons of zinc which was the maximum they were entitled to supply under their arrangements with the other Empire producers. The greater part of their total production was now supplied direct to H.M. Government, while a considerable part of the balance went indirectly into Government work.

Lead—The Secretary for Mines recently stated in reply to a Parliamentary question that supplies of lead in this country were adequate and that no shortage was anticipated. This may be true but consumers continue to complain at the slow rate at which deliveries are being made and would welcome an improvement in this respect.